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THESIS

APPLICATION OF THE GRAHAM DECISION
MODEL FOR SPARE PARTS TO THE
SACRAMENTO ARMY DEPOT

by

Michael E. Bonheim

December, 1989

Thesis Advisor: E. Neil Hart

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Application of the Graham Decision Model for Spare Parts to the Sacramento Army Depot

by

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Submitted in partial fulfillment
of the requirements for the degree of

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ABSTRACT

The purpose of this thesis is to assess the applicability of the Graham Decision Model for Spare Parts, a process flow chart developed by Lieutenant Ruth Graham, United States Navy, to the wholesale replenishment of communication and electronic repair parts by the Purchasing Division, Directorate of Contracting, Sacramento Army Depot, United States Army Depot Systems Command. The model was developed to be used as a decision tool by Department of Defense item managers and acquisition managers in identifying repair part candidates for Life Cycle Costing. This thesis tests the applicability of the decision model using selected communication and electronic repair parts. The researcher found that Life Cycle Cost factors are not considered during the wholesale replenishment of repair parts at the depot or inventory control point level. The researcher found that performance data are neither available to, nor determinable by, the user of the model in order to fully apply the model and make Life Cycle Costing decisions. The researcher proposes that performance data be collected by the inventory control points through the Commodity Command Standard System for use in Life Cycle Costing decisions. Additionally, the researcher proposes modifications to sequencing of the criteria used in the Graham Decision Model for Spare Parts and recommends two additional criteria for use in the decision process at the Sacramento Army Depot.

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I. INTRODUCTION

A. BACKGROUND

In June 1988 Lieutenant Ruth Graham, United States Navy, developed a decision model for identifying spare parts which lend themselves to Life Cycle Cost (LCC) purchasing methods and techniques. This model, a process flow chart, presented in her thesis, Life Cycle Costing in Spare Parts Procurement: A Decision Model (1988) consists of eleven steps. The first nine steps are questions which generate affirmative or negative responses based on information available to the purchasing agent at the time of the procurement action. With the exception of the first step in the decision process, consecutive affirmative responses lead the purchasing agent to the final two steps where the agent must complete calculations to determine a measure of utility in order to support the purchase using Life Cycle Costing techniques. A negative response, at any step other than step one, requires the purchasing agent to evaluate the circumstances of the purchase and suggests purchasing the part(s) using normal replenishment or provisioning processes, as applicable.

B. AREA OF RESEARCH

This research effort will be a study of the application of the decision model, developed by Ruth Graham in her master's thesis, for the procurement of communication and electronic spares within the Purchasing Division, Directorate of Contracting, Sacramento Army Depot, U.S Army Depot Systems Command. This application effort will be directed towards the replenishment process within the depot wholesale supply system.

C. RESEARCH QUESTION

The primary research question for this study is: How might the Graham Decision Model for Spare Parts be applied to the procurement of communication and electronic repair parts in the Purchasing Division, Directorate of Contracting, of the Sacramento Army Depot?

Subsidiary questions include:

1. What are communication and electronic repair parts?
2. What are the unique Life Cycle Cost aspects of communication and electronic repair parts?
3. How might the Graham Decision Model for Spare Parts be refined and improved for procurement of communication and electronic repair parts?

D. SCOPE, LIMITATIONS AND ASSUMPTIONS

This research effort will focus on the application of the decision model, developed by Ruth Graham, to procure communication and electronic spares within the Purchasing Division, Directorate of Contracting, Sacramento Army Depot. This thesis is concerned with the acquisition of communication and electronic repair parts, by the Purchasing Division, in support of the Directorate of Maintenance, Sacramento Army Depot, Depot Systems Command.

This thesis is not intended to be a detailed study of the logistics and maintenance support operation of the Sacramento Army Depot, but will provide the basic information necessary to understand the process and flow of replenishment requests within the wholesale system.

For the purpose of this research effort, the analysis and application of the Graham decision model will be limited to the replenishment process. The provisioning process of spare parts will only be discussed as it pertains to the Commodity Command Standard System (CCSS) in order for the reader to understand the requirements process. CCSS is an integrated data base within the Army wholesale inventory system. Additionally, this thesis is limited to the wholesale system as it applies to a depot activity, with the retail supply system intentionally omitted from this study.

It is assumed that the reader is familiar with Department of Defense acquisition concepts and procedures, as well as the Army Standard Depot System (SDS).

E. METHODOLOGY

The information presented in this thesis was obtained through literature searches using; the Defense Logistics Studies Information Exchange (DLSIE), the Defense Technical Information Center (DTIC),
other research studies, theses, Federal Directives, Sacramento Army Depot directives, and Sacramento Army Depot Standing Operating Procedures.

The purpose of the literature review was to obtain a thorough understanding of Life Cycle Cost concepts and principles in order to form a basis of knowledge to effectively evaluate Ruth Graham's decision model, apply the model to the purchasing of communication and electronic spares, and to propose improvements to the model for application at the Sacramento Army Depot.

The researcher selected 50 repair parts for testing the decision model and considers these parts a fair representation of the types of communication and electronic repair parts typically found in communication and electronic commodity items. Data on selected repair parts were collected from the Standard Depot System Demand History file, the Installation Support Activity Master Data Record, Depot Maintenance Stock Item Number Report, and from National Inventory Control Point Total Item Records (TIR's).

The researcher also conducted interviews with the Depot Purchasing Division Chief, the Purchasing Branch Chief, and experienced purchasing agents.

F. ORGANIZATION

This thesis is organized into six chapters. Chapter I provides the background, scope, limitations, assumptions, methodology, and organization of this thesis.

Chapter II provides the historical foundation for Life Cycle Costing policies within the Department of Defense, identifies Life Cycle Cost factors as they apply to spare parts, and introduces the reader to the Army's Wholesale Inventory System.

Chapter III contains a discussion of the mission, organization, function, and inventory management system (SDS) of the Sacramento Army Depot.

Chapter IV analyzes the decision model developed by Ruth Graham, examines its objectives, characteristics, and application procedures.

Chapter V presents the application of the Graham Decision Model for Spare Parts using selected communication and electronic repair parts routinely handled by the purchasing activity.

Chapter VI presents an analysis of Life Cycle Costing within the wholesale replenishment system and Sacramento Army Depot. It then presents an analysis of the application of the Graham Decision Model for Spare Parts to selected communication and electronic repair parts.

Chapter VII is a discussion of the conclusions and recommendations for application of the model for communication and electronic spares at the Sacramento Army Depot. Chapter VII also presents recommended improvements to the model for further application to communication and electronic repair parts.

G. SUMMARY

This thesis is a study of the application of a Life Cycle Costing decision model to the Purchasing Division, Directorate of Contracting, Sacramento Army Depot. The next chapter discusses Life Cycle Costing and provides a general understanding of the Army's wholesale inventory system.

II. BACKGROUND AND FRAMEWORK OF LIFE CYCLE COSTING

A. BACKGROUND

As far back as 1947, the Armed Services Procurement Regulation (ASPR), the Federal Government and Congress have been concerned with the long range costs, known today as Life Cycle Costs, of acquiring and procuring materials and services at the least cost to the Government. The Armed Services Procurement Regulation stated, "Whenever formal advertising is required and competition shall exist, the award shall be made to the responsible bidder whose bid will be most advantageous to the government, price and other factors considered." "Other factors" in the ASPR included the total costs of ownership, but did not change how procurement practices were conducted, price continued to dominate the source selection process. [Ref. 1:p. 1]

From 1947 to the early 1960's, the primary factors considered in evaluating and selecting contractors were based on "performance" and "schedule" requirements. Performance was based on a system's ability to combat a foreseen threat, while schedule was whether the system could be developed on time to meet the threat. [Ref. 2:p. 35]

In the early 1960's, then Secretary of Defense McNamara developed the initial Life Cycle Cost concept. Its premise was to spend relatively more "up front" to gain savings in support and operating costs after fielding of a weapon system. [Ref. 3:p. 2]

This concept was designed primarily because of increasing concern over total lifetime costs of major weapon systems. As a result of Secretary McNamara's initiative, the Department of Defense formalized the process with greater emphasis placed on cost estimates, reliability, and performance. These three factors above were considered to be the primary cost principles upon which Life Cycle Costs should be measured. The process of evaluating the lifetime costs of a system is the Life Cycle Costing. [Ref. 4:p.10]

The Life Cycle Cost of an item is defined as, "Its total cost at the end of its lifetime--includes all expenses for research and development, production, modification, transportation, introduction of the item into inventory, new facilities, operation support, maintenance, disposal and any other costs of ownership, less any salvage revenue at the end of its lifetime." [Ref. 3:p.9]

In late 1963, the then Assistant Secretary of Defense for Installation and Logistics (I & L) undertook a study of the effect that price competition may have on life cycle equipment costs. The initial effort was directed towards minor assemblies, sub-assemblies, and repair parts. That study concluded and recommended that [Ref. 1:p. 10]:

1. Test and study of logistical costs in procurement of non-commercial repairable equipment was needed.

2. Contract award of such contracts should be based on the lowest price per unit of service life.

In 1965, the then Assistant Secretary of Defense (I & L) established a Life Cycle Costing Task Steering Group to study and implement Life Cycle Costing in material acquisition. The steering group established five prerequisites for using the Life Cycle Cost concept [Ref. 1:p.12]:

1. Ability to forecast the amount of costs with reasonable confidence.

2. Ability to verify cost amounts prior to award or hold contractors responsible for them.

3. Ability to state the method of evaluating the cost definitively and with clarity.

4. Economic feasibility of incorporating cost analysis and associated tests in the procurement cycle.

5. The elements included should be those in which there is reasonable expectation of differences in Life Cycle Costs of bids or proposals submitted.

In 1971, the Department of Defense issued DOD Directive 5000.1 establishing the Life Cycle Cost analysis as a requirement in the acquisition process of major weapon systems. The Department of Defense subsequently issued DOD Directive 5000.2 which outlined the requirement to consider total cost at each milestone in the acquisition process, including ownership costs. This, in essence, was to require that costs of acquisition and ownership be established as separate cost elements and translated into firm design-to-cost, and life cycle cost constraints, for system selection in full scale engineering development. Design-to-cost is a concept that establishes cost elements as goals to achieve a balance between Life Cycle Costs, performance, and schedule.

In September 1973, the Department of Defense issued Defense Procurement Circular #115 which amended the Armed Services Procurement Act adding [Ref. 5:p. 21]:

> Since the cost of operating and supporting the system or equipment for its useful life is substantial and, in many cases greater than the acquisition cost, it is essential that such cost be considered in development and acquisition decisions in order that proper consideration can be given to those systems or equipment that will result in the lowest life cycle cost to the government.

Despite this and previous guidance, in 1974, the General Accounting Office continually found weaknesses in Department of Defense management of Life Cycle Cost goals, but continued to encourage its use. [Ref. 6:p. B-1]

The GAO, in their review in 1974, did cite a positive application of Life Cycle Costing in the procurement of batteries. The GAO found life cycle costing for battery procurement adequate in using the price per cycle approach. [Ref. 6:p. 7]

On 25 July 1983, the then Secretary of Defense Casper Weinberger issued a ten point memorandum and followed up with 25 initiatives, in August 1983, with his assessment and recommendations on improving the acquisition process of spare parts. The Secretary of Defense did not specifically address Life Cycle Costing directly within either memorandum, however contained within his twenty five initiatives is the pure essence of Life Cycle Costing. The Secretary called for the education and instruction of defense acquisition personnel to enable them to question and challenge any procurement action (for spare parts) where the price appears to be unrelated to the repair parts intrinsic value. The "intrinsic value" of a repair part is its measure of utility, measurable in a level of performance. This became the basic principle of Life Cycle Costing in spare parts procurement used today by the Department of Defense (DOD). [Ref. 7]

With the implementation of the Defense Acquisition Regulation (1977) and the Federal Acquisition Regulation (FAR, 1984) the Life Cycle Cost concept has been further defined. Today, FAR Part 7.101 defines Life Cycle Cost as, "The total cost to the government of acquiring, operating, supporting, and disposal of items being acquired."

The FAR describes Life Cycle Cost management as a method to insure the Government's needs are met in the most efficient, economical and timely manner.

At about the same time the FAR was implemented, the Office of Federal Procurement Policy (OFPP) was reviewing spare parts procurement practices in the Department of Defense. Their report to Congress did not specifically address Life Cycle Costs or the Life Cycle Cost management concept, but did reveal that the process of procuring repair parts could be improved during design, development, provisioning, and replenishment phases. Their study revealed [Ref 8]:

1. Planning for repair parts should begin during the conceptual stage of a weapon system.

2. Planning in initial provisioning identifies the initial spare parts required to support the system and encourages combining spare parts orders with production contracts.

3. High prices in later years resulted from lack of pricing information and inadequate review of available information.

OFPP's report essentially revealed non-compliance in using Life Cycle Cost principles during the acquisition process, but did not specifically state so.

In June 1986, the Blue Ribbon Commission of Defense Management, in their report to the President, again indirectly addressed Life Cycle Cost. One of the Commission's recommendations was that the Department of Defense place emphasis on using technology to reduce costs by reducing unit acquisition costs and by improving reliability, operability, and maintainability. This in essence is Life Cycle Cost management. [Ref. 9:p. 56]

In June 1988, LT Ruth Graham, USN, developed a Life Cycle Costing model for repair parts acquisition as a requirement for her master's at the Naval Postgraduate School, Monterey, CA. The model was designed to serve as a tool for identifying candidates for Life Cycle Costing for spares by matching the criteria applicable in her model. LT Graham pursued her research by answering the primary research question, "What decision process should be used to determine the application of Life Cycle Costing to spare parts?". In doing so, LT Graham developed a decision model.

B. DEFINING LIFE CYCLE COSTS

Life Cycle costs are defined as the total of <u>acquiring</u>, <u>operating</u>, <u>supporting</u>, and <u>disposing</u> of a system.

Acquisition costs consist of the costs of research and development, production and construction, plus profit.

Research and Development Costs consist of "...feasibility studies; system analysis; detailed design and development, fabrication, assembly, and test of engineering models; initial system tests and evaluation; and associated documentation." [Ref. 4:p. 14]

Production and construction costs consist of [Ref. 4:p. 14]:

> ...the costs of fabrication, assembly and test of operational systems (production models); operation and maintenance of the production capability; and associated <u>initial</u> logistic support requirements (e.g., test and support equipment development, spare/repair parts provisioning, technical data development, training, entry of items into the inventory, facility construction, etc.).

Profit is the net difference between the cost and revenue from the sale of a product or service.

Operating and Support costs, the largest part of Life Cycle Costs, are defined as, "...costs incurred during the use of an item (personnel, fuel, and operating support), and support costs are those for maintenance, provisioning, support equipment, training, technical manuals, and other nonoperating support functions (site preparation, installation and security requirements)." [Ref. 3:p. 111]

Lastly, Disposal costs, which are usually small relative to others costs incurred, complete the Life Cycle Cost composition.

Ruth Graham, in her thesis, defined the costs associated with repair parts procurement as including acquisition, operating and support, and disposal costs as with major weapon system acquisition. However, some differences were noted. Whereas major weapon system Life Cycle Costs are in terms of dollars, spare parts are expressed in terms of cost per some level of performance. Additionally, Ruth Graham proposes that research and development costs should be considered "sunk costs" on the basis that spare parts replace existing items, therefore these costs should not be counted. [Ref. 4:p. 17]

A further discussion of spare parts' Life Cycle Costing characteristics and factors will follow in the analysis of the decision model (Chapter VI).

C. DEFINING SPARE PARTS

Ruth Graham defined two categories of spare parts: consumable and repairable.

Consumable spare parts are defined as, "...spare parts that are disposed of when they fail or are used up." They also tend to cost less than repairable parts. [Ref. 4:p. 28]

Repairable spare parts are defined as, "...spare parts that are repaired when they fail (or on a pre-arranged rework cycle) and then returned into service." [Ref. 4:p 28]

The Army Logistics Management Center, Fort Lee, Virginia, distinguishes these two categories as repair part and spare part. Repair parts are defined as, "Consumable bits and pieces, that is, individual parts or non-repairable assemblies, required for the repair of spare parts or major end items." Spare parts are defined as, "Repairable components or assemblies used for maintenance replacement purposes in major end items of equipment." [Ref. 10:p. 18]

Throughout this thesis the terms "spare part" and "repair part" will be used interchangeably to refer to both consumable and repairable items.

D. ACQUISITION OF REPAIR PARTS

Repair parts acquisition planning should be part of the major systems acquisition process. Basic design and functions are decided upon during early phases of the system acquisition and affect requirements throughout the operation and support of the system. The Office of Federal Procurement Policy, in their Review on Spare Parts Procurement Practices of the Department of Defense, stressed standardization, reliability in choosing a contractor, and emphasized the importance of planning and programming for budget requirements for spares. [Ref 8:p. 156]

It is during the Full Scale Engineering Development (FSED) phase of the acquisition cycle that repair parts are identified for provisioning by the contractor and enter into the Department of Defense inventory. [Ref. 10:p. 42]

There are two processes for acquiring repair parts. The first, mentioned above, is provisioning. The provisioning process provides spare parts for initial fielding of the equipment. The second process is replenishment. Replenishment of spare parts is accomplished through the designated Inventory Control Point (ICP), based on requirements and demands, and does not normally involve the program manager. [Ref. 10:p. 42]

A replenishment part is defined as [Ref. 10:p. 18]:

> A part, repairable or consumable, purchased after provisioning of that part for: replacements; replenishment of stock; or use in the maintenance, overhaul, and repair of equipment such as aircraft engines, ships, tanks, vehicles, guns and missiles, ground communications, and electronic systems, ground support and test equipment.

E. THE WHOLESALE INVENTORY SYSTEM

The Department of the Army standard wholesale logistics operation is performed by Army Material Command (AMC) and is managed through its Commodity Command Standard System (CCSS). There are ten Major Subordinate Commands (MSC) within AMC of which six operate Inventory Control Points within the Department of the Army. The United States Army Depot Systems Command (DESCOM), one of the MSC's, is responsible for the command and control of the 12 Army Depots, and ten Depot Activities. The mission of the wholesale system is to make items available to the retail system by acquiring items for inventory through purchases from industry, fabrication, rebuild and overhaul, and cannibalization of unserviceable items in order to sustain the force. DESCOM is responsible for the receipt, storage, issue and maintenance of assigned commodities. [Ref. 10:p. 1-5]

This thesis evaluates the application of a Life Cycle Costing decision model for the replenishment of communication and electronic spare parts at a depot maintenance activity. This research effort centers on the replenishment process. However, in order to develop an understanding of the Commodity Command Standard System the entire system will be reviewed, including the provisioning process.

The Commodity Command Standard System is an automated management system of secondary items and repair parts. Secondary items are items other than major end items. Examples include assemblies, subassemblies, components, and sub-components. The Department of the Army has two primary objectives in managing secondary items and repair parts. First, to support the new equipment with sufficient quantities of initial stockage. Second, to support the equipment while being deployed to operational units in the field. [Ref. 10:p. 108]

The functional areas of the Commodity Command Standard System are: provisioning, cataloging, supply management, stock control, financial management, procurement and production, international logistics and maintenance. Data are accessible by all functional areas through the integrated data base. The data are stored by data elements in files. There are approximately 35 master files within the system.

Initial stockage (provisioning) within CCSS involves a transactional relationship between three of the functional areas: provisioning, cataloging and supply management. Initial provisioning is accomplished by the Commodity Command Standard System by a computational process between two major files of the system. This facet of the system is known as the Automated Requirements Computation System. The two major files for this action are the Provisioning Master Record (PMR) file and the End Item Parameter (EIP) file. The PMR file contains data collected from the contractor through research and development, and through logistics support analysis. This collection of data begins two to three years prior to initial fielding of the equipment. The PMR file contains a "family tree" of all assemblies, sub-assemblies, components, sub-components of the major end item. The quantity usage data, essentiality code, replacement rates, unit price, and quantity per end item are a representation of the type data stored in the PMR file.

The EIP file stores density requirements, production schedules, and fielding priorities and locations. [Ref. 10:p. 109]

The Provisioning Master Record file is also used to identify repair parts which currently exist in the Department of Defense inventory system. Secondary items which do not have assigned National Stock Numbers (NSN's) are referred to cataloging for consideration. Cataloging is one of the functional areas of CCSS, but will not be discussed in this thesis. Cataloging is the responsibility of the Defense Logistics Service Center (DLSC).

Supply management consists of the development of the Support List Allowance Card (SLAC). The SLAC is a listing of organizational and direct support maintenance stockage items and quantities.

Replenishment stockage is based on demand and quantity usage and is the responsibility of the stock control functional area. Demand history data are compiled in the Demand Return Disposal (DRD) file. The DRD file maintains data on requisitions, serviceable and unserviceable returns, and disposal actions from the field. These data entries are available through the processing of information through the Standard Intermediate Level Supply system (SAILS) and through the Standard Depot System (SDS). (The SAILS system is used by Corps/Installation level activities within the Army. The Standard Depot System will be discussed in Chapter III of this thesis.) CCSS then uses the DRD file to compute average monthly demand rates and recommend future stockage levels based on past and anticipated requirements. [Ref. 10:p. 111]

As stated earlier, it is the Item Manager that is responsible for the replenishment process. The Item Manager receives information from the CCSS and generates the Procurement Work Directive (Purchase Request). The Procurement Work Directive is then forwarded to the financial management functional area and procurement and production functional area. Procurement and production functional area personnel then award the contract based upon the PWD. The financial management functional area will not be discussed in this thesis. The procurement and production functional area will be discussed in Chapter III using the Sacramento Army Depot as a typical example.

The final functional area is international logistics and maintenance. The maintenance function of CCSS, the allocation of repair and overhaul work, will also be discussed in Chapter III as applicable to the Sacramento Army Depot.

F. SUMMARY

This chapter provided an overview of the evolution of Life Cycle Costing, defined the categories of repair parts, and discussed the Army's wholesale inventory system. The following chapter discusses the mission, organization, and function of the Sacramento Army Depot.

III. SACRAMENTO ARMY DEPOT

A. INTRODUCTION

This chapter will discuss the mission and functional responsibilities of the directorates involved in maintenance, supply, and purchasing within the Sacramento Army Depot. It will describe the Standard Depot System (SDS) internal to the depot and SDS's external interface with the Commodity Command Standard System (CCSS).

B. MISSION

The mission of the Sacramento Army Depot, United States Army Depot Systems Command, Sacramento, California, as outlined in the Sacramento Army Depot (SAAD) Regulation 10-2, May 1989 is as follows [Ref. 11:p. 2-1]:

> Serves as primary depot for repair, rebuild, and modification of selected electronic/avionic items, laser range finders, Army/Air Force airborne cryogenic units, and Joint Service Interior Intrusion Detector Systems (JSIIDS); assembly/construction of Quick Reaction Projects such as self-contained radio transmitter sites, and special fabrication of general purpose and communication shelters. Serves as a nondistribution supply depot for electronic/avionic items, and cold storage batteries. Provides installation support to tenant activities and to other outside agencies. Provides maintenance and supply training to Reserve units and personnel.

C. ORGANIZATION

As indicated in Chapter I, Sacramento Army Depot's parent command is the United States Army Depot Systems Command (DESCOM), one of the Major

Subordinate Commands (MSC's) under Army Material Command (AMC). The Depot Commander reports directly to Commander DESCOM.

The Sacramento Army Depot activity consists of eight directorates and ten attached/tenant activities. The eight directorates include: Directorate of Military Personnel, Community Activities and Security, Directorate of Resource Management, Directorate of Quality Assurance, Directorate of Western Region Civilian Personnel, Directorate of Information Management, Directorate of Maintenance, Directorate of Supply, and the Directorate of Contracting. The two major tenant activities are the Television Audio Support Activity (TASA) and the Navy Broadcasting Service Detachment. Tenant activities are support and service activities such as the Army Health Clinic.

This thesis is concerned with only three Directorates: Directorate of Maintenance, Directorate of Supply, and the Directorate of Contracting.

D. DIRECTORATE OF MAINTENANCE

The Directorate of Maintenance is responsible for performing the depot maintenance mission. The Directorate of Maintenance consists of eight divisions involved in planning, programming, repair, overhaul, rebuild, modification, and conversion of communication and electronic commodity items. In addition to the depot maintenance work, upon request, the divisions will provide maintenance assistance and technical assistance to material users in the field. The eight divisions within the Directorate of Maintenance are: Maintenance Planning/Analysis and Engineering Division, Special Projects Division, Maintenance Support Division, Electronic Communication/Transportable Division, Automated Systems Division, Signal Intelligence/Radar Division, Electro-Optics Division, and the Avionics Division. [Ref. 11:p. 9-1]

The production facilities within the various divisions are involved in overhaul, rebuild, conversion, modification, and repair. Overhaul and rebuild are the highest level of maintenance performed at the depot. Overhaul is the process of returning unserviceable items to a completely serviceable condition. Rebuild exceeds overhaul in both complexity and expense as the rebuild process attempts to restore an item to the original manufacturer's specifications. Conversion is the alteration of an item such that the mission and performance characteristics of the item change. Modification is the alteration of an item such that the mission and performance characteristics of that item do not change. Repair is the maintenance action required to return unserviceable equipment to a serviceable condition. The divisions within the Directorate of Maintenance perform these maintenance actions on the following communication and electronic commodity items: tactical and non-tactical computers, night vision/thermal imagery devices, lasers, electronic and signal warfare systems, tactical and non-tactical communication/radio systems, aviation electronics and instruments, target acquisition equipment, radar, meteorological equipment, tactical and non-tactical television equipment, facsimile equipment, audio visual and sound recording equipment, transportable ground/air/vehicular shelters, and communication and electronic test equipment.

As indicated, upon request the divisions within the Directorate of Maintenance are required to provide maintenance and technical assistance to field activities. Depot maintenance assistance is the use of qualified maintenance personnel and their skills to perform on-site depot level maintenance. Depot technical assistance is on-site assistance of a technical nature which is limited to advice, guidance, and instruction.

E. DIRECTORATE OF SUPPLY

The Directorate of Supply is responsible for the planning, programming, managing, and transporting of wholesale and retail supplies in support of the depot mission. The Directorate of Supply consists of four divisions: Transportation Division, Production Planning and Control Division, Inventory Management Division, and General Supply Division. These divisions are involved in the receipt, storage, issue, accountability, preservation, packaging, and shipping of materials and supplies.

The Accountable Property Branch within the Inventory Management Division maintains the stock record accounts and is responsible for replenishment from the wholesale system [Ref. 11:p. 10-2]. Third Quarter Fiscal Year 1989 statistics, considered by the Accountable Officer to be a fair representation of the quarterly volume of transactions within the depot activity, show of the 22,500 requisitions processed about 10 percent were to fill urgent requirements with the remaining 90 percent filling normal stockage requirements and other non-urgent requirements

[Ref. 12]. Third Quarter statistics reflect that 18% of the 22,500 requisitions required local purchase action. Sources of replenishment are displayed in Table 1.

TABLE 1
DEPOT INVENTORY MANAGEMENT STATISTICS

SOURCE OF REPLENISHMENT	PERCENT OF TOTAL REQUISITIONS*
ARMY	10%
DLA	59%
GSA	12%
LOCAL PURCHASE	18%
OTHER	1%

SOURCE: DEPOT PROPERTY THIRD QUARTER FISCAL YEAR 1989 REPORT, INVENTORY MANAGEMENT DIVISION, 20 OCTOBER 1989.
(* TOTAL REQUISITIONS THIRD QUARTER FY 89: 22,500)

F. DIRECTORATE OF CONTRACTING

The Directorate of Contracting is responsible for providing procurement support to the depot tenant activities, attached activities, TASA, other non-AMC agencies, and the Pacific Theater. The Directorate of Contracting consists of four divisions. The Support Division is responsible for administration, analysis, and policy compliance. The Purchasing Division is responsible for small purchases under $25,000. The Contracts Division is responsible for preparing and awarding contracts for supplies, equipment, construction, research, development, and services over $25,000. Finally, the Contract Administration Division is responsible for post award administration of contracts. [Ref. 11:p. 7-2]

As explained in Chapter I, this thesis is limited to the acquisition of repair parts by the Purchasing Division. The Purchasing Division is responsible for preparing, soliciting, and awarding of small purchase and delivery orders. Solicitations are made orally by telephone or by placing the Invitation for Bid (IFB)/Request for Proposal (RFP) in the Commerce Business Daily (CBD). Purchases are conducted in accordance with FAR Part 13, DOD FAR Supplement Part 213, and local directives. Methods of purchasing include: Blanket Purchase Agreements (BPA's), Basic Ordering Agreements (BOA's), Purchase Orders, Purchase Invoices, Delivery Orders, and Impress Funds.

The Purchasing Division consists of three branches: Branch A supports TASA, Branch B supports the depot maintenance activities and other tenant activities, and Branch C is responsible for service and construction purchases. Branch A and Branch B are the only branches involved in the purchase of communication and electronic repair parts within the Purchasing Division. Their specific functions include [Ref. 11:p. 7-5]:

1. Preparing and awarding purchase and delivery orders for supplies, non-personal services and construction in amounts up to and including $25,000.

2. Reviewing and selecting sources of supply and service, solicits oral, written or telephonic quotations, and determines method of purchase.

3. Establishing blanket purchase agreements and basic ordering agreements.

4. Preparing justification for unusual requirements, absence of competitive bidding, authority for solicitation, prepares necessary determinations and findings.

5. Establishing and maintaining purchase operating files to include registers and other records.

6. Reviewing price quotations and determining reasonableness of price.Soliciting and awarding non-appropriated fund supply contracts exceeding $5,000, service contracts exceeding $2,500 and construction contracts estimated to exceed $2,000. Establishes non-appropriated fund blanket purchase agreements.

7. Administers all Blanket Purchase Agreement's (BPA's) and processes payment to Finance and Accounting.

The researcher conducted interviews with the purchasing branch chief and the purchasing agents. The interviewees were informed the interviews would be non-attributable in order to encourage open and uninhibited dialogue and transfer of information. Therefore, no particular comment is ascribed to any individual purchasing agent. The questions, shown below, were asked to each interviewee. A consensus of the answers are presented following each question.

1. What factors do you consider when making a repair parts purchase?

The primary factor considered by the purchasing agents was the purchase price. Purchasing agents consulted previous purchases, if any existed, as a basis of comparison. If the last purchase was made in the previous year, the price per unit for this year's buy should not be greater than 25 percent over last year's price per unit in order to be reasonable. When the purchase price is greater than $2,500 or the part is being purchased for the first time the purchasing agent must seek competition for the buy. Purchasing agents indicated however that the Contracting Officer has the responsibility of determining price reasonableness.

2. What do you find unique about communication and electronic spare parts?

Most buyers were very experienced in purchasing communication and electronic spare parts and found these parts to have very technical specifications. In most cases the buyers indicated they found themselves purchasing commercially off-the-shelf items with the solicitation calling for form, fit and function type requirements. What the buyers found most unique was that most communication and electronic parts were not interchangeable and sometimes obsolete in the commercial market.

3. What Life Cycle Cost techniques are used in the purchasing of spare parts?

Without exception the purchasing agents were not aware of any specific Life Cycle Costing methods or techniques. Nor were any purchasing agents aware of the Department of the Army's emphasis on Life Cycle Costing.

4. What is the Life Cycle Costing policy within the Purchasing Division?

There is no Life Cycle Costing policy within the Purchasing Division. Therefore, the purchasing agents were unable to answer this question.

5. What is your methodology in determining if you will use Life Cycle Costing principles?

There is no Life Cycle Costing policy within the Purchasing Division. Therefore, the purchasing agents were unable to answer this question.

6. How are Spare Parts purchased?

Purchasing agents indicated that spare parts are purchased using the small purchase procedures as directed in the Federal Acquisition Regulation (FAR), DOD FAR Supplement Part 213, and other local directives. The purchasing agents indicated that about 95% of all purchases were awarded competitively. The most preferred method of purchasing was the use of Blanket Purchase Agreements (BPA). The purchasing agents indicated that it cost about $25.00, in administrative costs, to complete a single purchase using a BPA compared to $250.00 to prepare and administer a single contract.

During Fiscal Year 1988 the Purchasing Division completed 13,096 purchase actions at $29.6 Million. During Fiscal Year 1989 the Purchasing Division completed 15,567 purchase actions at $36.5 Million. Of these purchases in Fiscal Year 1989, the Purchasing Division completed 2,557 purchasing actions for the Directorate of Maintenance at $27.7 Million. The Purchasing Division was unable to identify how many of these purchasing actions were completed using BPA's and how many were awarded on separate contracts. [Ref. 12]

G. THE STANDARD DEPOT SYSTEM

The Standard Depot System (SDS) is an automated data processing system used throughout the 12 Army Depots and ten Depot Activities. This standardized system links and integrates the functional areas within an individual depot, serves to link one depot to another, and serves as a communication and data transfer network with the wholesale inventory system.

H. STANDARD DEPOT SYSTEM INTERNAL TO THE DEPOT

The Standard Depot System integrates the functional areas providing a total use capability for remote computer input and output within the Depot activity. The functional areas linked with SDS include: Financial Management, Depot Supply, Quality Assurance, Maintenance Production Planning and Control, Civilian Personnel and Manpower Systems Management [Ref. 13:p. 18-2]. The reader should note that the Directorate of Contracting, although not a functional area of SDS, is also linked into SDS.

Repair part requirements are generated within the various depot work stations. These requirements are annotated in the work packet and forwarded to production control. Production control inputs the requirement into SDS. Several actions can then occur. First, if the item is stocked within the maintenance section, shop stock or bench stock, production control is alerted and stocks drawn from on-hand inventory. Next, SDS queries other maintenance sections stockages to see if assets are available. If so, a material release order against the work packet is issued. If the repair part is not stocked within the activity, SDS automatically generates the requirement to Depot Supply. At this point Depot stockages are queried and if stocks are available they are issued. If not, SDS generates a requirement to the National Inventory Control Point (NICP) responsible for that commodity item. At this time, based on the Acquisition Advice Code (AAC) and/or status code, the item manager within Depot Supply will either establish the due-in from the NICP or submit a purchase request to the Purchasing Division.

In addition to being linked into SDS, each purchasing agent is linked into a network with automated purchasing functions and vendor information. Upon completion of a purchase order (i.e. receipt of goods or services) contract close out actions are commenced. Purchasing agents and Item Managers must make dual entries in-order to provide close-out information into SDS. Automated processes provide necessary information to the functional areas of SDS.

I. STANDARD DEPOT SYSTEM EXTERNAL TO THE DEPOT

As indicated, if the requirement cannot be met within the Depot activity SDS will forward the requirement to the NICP responsible for that commodity item. It is at this point where SDS interfaces with the Commodity Command Standard System (CCSS) and one of three options will occur. One, the NICP will have assets on hand, a material release order issued, and the item shipped to the requiring depot. Two, the NICP will not have assets on hand, a due-out issued to the Depot, and a Procurement Work Directive (PWD) generated through CCSS. Three, the item manager at the NICP will not be able to fulfill the requirement and will notify the Depot item manager that the item must be purchased or fabricated by the depot activity. The Department of the Army spends approximately $2.2 Billion, per year, in the replenishment of repair parts. [Ref. 14]

Another function of SDS is to serve as a communication link for maintenance requirements between DESCOM and the Depot. Within this link, DESCOM assigns and allocates depot repair and overhaul work. Assignment of Depot maintenance workload is accomplished between CCSS and SDS by the international logistics and maintenance functional area of CCSS.

For example, Communication and Electronics Command (CECOM), one of the ten Major Subordinate Commands is responsible for the wholesale inventory management of all communication and electronic commodity items within the United States Army. As a Major Subordinate Command, CECOM is responsible for requirements determination. CECOM passes these requirements (via CCSS) through the Maintenance Data Management System (MDMS) to Depot Systems Command. Depot Systems Command is responsible for meeting CECOM's requirements. This can be accomplished by one of two methods. First, through the issue of serviceable items from depot inventory. Second, by returning unserviceable equipment to a serviceable condition through depot rebuild or overhaul. Depot Systems Command is responsible for assignment and allocation of work to depots, such as Sacramento Army Depot. Depot Systems Command makes assignments (via SDS) through Master File Maintenance (MFM). Master File Maintenance is the computer file by which Depot Systems Command maintains status of depot workloads.

J. SUMMARY

This chapter provided an overview of the mission, organization, and function of the Sacramento Army Depot. It examined SDS and its interface with CCSS. The following chapter provides an analysis of the Graham Decision Model for Spare Parts and its application to communication and electronic repair parts.

IV. THE DECISION MODEL

A. INTRODUCTION

This Chapter provides an overview of the objective, application method, and characteristics of the Graham Decision Model for Spare Parts. In addition to discussing the characteristics of the model, as developed by Ruth Graham, this researcher further defines each criterion as it pertains to the replenishment process of communication and electronic repair parts at the Sacramento Army Depot. Other characteristics discovered during this researcher's effort are also presented.

B. OBJECTIVE OF THE MODEL

The objective of Ruth Graham's thesis was to develop a decision process to be used in determining the applicability of Life Cycle Costing to spare parts. In doing so, she developed a model to be "...used by item managers and contracting personnel for identifying spare part candidates for procurement using life cycle costing techniques." [Ref. 4:p. 61]

Life Cycle Costing has the ultimate objective of obtaining "...spare parts at the lowest cost per level of performance." [Ref. 4:p. 41] This performance level is used to compute the cost per level of utility and is used as a source selection criterion. [Ref. 4:p. 44]

C. METHOD OF APPLICATION

The Graham Decision Model for Spare Parts was developed for application to both the provisioning and replenishment process. This thesis is concerned with the wholesale replenishment of communication and electronic repair parts at the Sacramento Army Depot.

The Graham Decision Model for Spare Parts allows the item manager or contracting personnel to use the criteria within the model to evaluate each spare part based on Life Cycle Costs, not just the current low price being offered for the quantity being procured. Should the candidate successfully pass all the criteria set forth in the model, it is considered to be a candidate for Life Cycle Costing methods and techniques. [Ref. 4:p. 66]

The criteria developed by Ruth Graham were based on the "general" characteristics of spare parts she repeatedly encountered in her research, while others are characteristics she believed important in the identification process. [Ref. 4:p. 42]

D. CHARACTERISTICS OF THE MODEL

Ruth Graham discussed 13 characteristics of spare parts. She then went on to select those characteristics which she considered most important in evaluating a repair part as a candidate for Life Cycle Costing. These characteristics were then arranged from the "...characteristics most clearly defined and easiest to identify to that characteristic most difficult to define and identify." [Ref. 4:p. 42]

This ordering arrangement was done in an effort to reduce the workload for the user of the model. Ruth Graham believed that the characteristics most easily identified should be considered first in order to quickly eliminate those parts that are not viable candidates for Life Cycle Costing. This early elimination would prevent the user from time consuming data collection and calculations.

Ruth Graham identified the following order of consideration:

1. Urgency of Requirement
2. Shelf Life Constraints
3. Availability on the Open Market
4. Maturity
5. Total Procurement Cost
6. Durability/Reliability
7. Technical Data Considerations
8. Performance Measures
9. Performance Level
10. Cost per Level of Performance
11. Desired Cost per Level of Performance

This ordering of the characteristics gave rise to the Graham Decision Model for Spare Parts, a decision flow chart, for identifying candidates for Life Cycle Costing techniques. (The Graham Decision Model for Spare Parts is presented in Appendix A.)

E. URGENCY OF REQUIREMENT

Step One: Urgency of Requirement is concerned with "...the time frame in which the spare part is needed." [Ref. 4:p. 44] Ruth Graham estimated that six months would be required in order to gather technical data, performance data and complete the contracting process. If the requiring activity's need must be met within less than six months the model recommends using normal replenishment processes. Normal replenishment processes involve using the conventional policies and procedures available to the item manager/purchasing agent. These conventional procedures include replenishment through the Commodity Command Standard System (CCSS), Standard Depot System (SDS), and using the lowest price as basis for contract award. If there is no urgent requirement, proceed to step two. [Ref. 4:p. 46]

The requiring activity designates the urgency of the requirement through the selection of the Priority Designator (PD). The PD is determined through a correlation of the Force Activity Designator (FAD) and Urgency of the Need Designator (UND). Sacramento Army Depot is designated a FAD III activity authorized to use PD's 03, 06, and 13 as shown in Table 2.

Guidance on selection of Priority Designator is found in Appendix G, Sacramento Army Depot Regulation 725-2. [Ref. 15:p. 2-1]

TABLE 2
CORRELATION OF UND AND FAD

EFFECT ON MISSION	APPROPRIATE UND	FAD III PD'S
Unable to Perform	A	03
Performance Impaired	B	06
Routine Requirement	C	13

SOURCE: Appendix G, Sacramento Army Depot Regulation 724-2.

In short, urgent requirements are identified by Priority Designator 03, while non-urgent requirements are identified by Priority Designators 06 and 13.

F. SHELF LIFE

Step Two: Shelf Life refers to "...the length of time that the item may remain in storage." [Ref. 4:p. 40] Ruth Graham proposed that if the shelf life is less than six months, the time required to apply the *Graham Decision Model for Spare Parts*, the procurement should be made using standard replenishment procedures. If the shelf life is greater than six months, or has no shelf life, continue to step three. [Ref. 4:p. 46]

The Defense Logistics Agency Customer Assistance Handbook defines a shelf life item as "...an item of supply possessing deteriorative or unstable characteristics to the degree that a storage time period must be assigned to assure issue of satisfactory material." [Ref. 16:p. 28]

Army Regulation 735-110 contains a comprehensive listing of shelf life codes and differentiates shelf life codes into two types: Type 1 and Type II.

1. Type I items have a non-extendable shelf life. It has been determined through technical testing that these items have a definite shelf life.

2. Type II items may have the shelf life extended following completion of testing, inspection, or restorative processes.

Shelf Life Codes for specific items can be determined by inquiry into the Army Master Data File (AMDF), HAYSTACK, or by consulting potential manufacturers and suppliers of the item. HAYSTACK is a network operated by Ziff Davis Company, which is tied into the Federal Supply Catalog (1989). HAYSTACK is accessible to any Department of Defense agency that has enrolled in the data base. The Sacramento Army Depot is enrolled and has access to HAYSTACK. Those codes which have a shelf life of six months or less are found in Table 3.

TABLE 3
SHELF LIFE CODES OF SIX MONTHS AND LESS

	SHELF LIFE CODES	
SHELF LIFE (IN MONTHS)	TYPE I	TYPE II
1	A	
2	B	
3	C	1
4	D	
5	E	
6	F	2

SOURCE: [Ref. 16:p. 28]

G. AVAILABILITY ON THE OPEN MARKET

Step Three: Availability on the Open Market refers to "how readily the part can be obtained on the open market." [Ref. 4:p. 38] Ruth Graham believed that competition would motivate contractors to increase performance criteria at lower costs. Therefore, if adequate competition does not exist the repair part should be acquired using normal replenishment processes. If adequate competition exists proceed to step four. [Ref. 4:p. 41]

The user of the model has several approaches in determining the Availability on the Open Market. First, the user can consult local vendor listings, issue solicitation documentation, and await vendor proposals. The purchasing agent may also contact the Small Business Office to gain information on possible sources. Next, the user of the model can access HAYSTACK. Another alternative is to contact the item manager at the National Inventory Control Point (NICP). The item manager can access the Commodity Command Standard System (CCSS) and relate historical procurement information back to the user of the model.

H. MATURITY

Step Four: Maturity refers to "...how well developed the design of the spare is." [Ref. 4:p. 40] Ruth Graham believed that state-of-the-art repair parts were not suitable for Life Cycle Costing as performance measures were too difficult to determine and lacked historical data for decision making. Therefore, purchases of state-of-the-art items should be completed through normal replenishment processes. For items of mature design, those for which design is stable and have been without changes and modifications to drawings and design, proceed to step five.

The very nature of communication and electronic systems makes the process of determining the level of maturity of repair parts a complex issue. Therefore, the user, if not technically proficient, should seek the advice and assistance from technical engineers, both within the depot and at the NICP. Seeking assistance from technically qualified individuals prevents eliminating many communication and electronic repair parts which may have otherwise been good candidates for Life Cycle Costing methods.

The lack of recent changes to drawings and specifications is a good indication the item is of a mature design, assuming that all necessary changes indeed have been made.

I. TOTAL PROCUREMENT COST

Step Five: Total Procurement Cost refers to the "...unit price times the quantity ordered." [Ref. 4:p. 38] Ruth Graham choose an arbitrary figure of $10,000 as the cut-off cost for total cost. Procurements exceeding $10,000 should proceed to step six. Procurements not exceeding $10,000, because of the arbitrary nature of the cut off, should evaluate two sub-parts of Total Cost: Demand and Unit Price.

1. Demand

Demand refers to "...how frequently and in what quantity the item is required." [Ref. 4:p. 37] Ruth Graham chose an arbitrary figure of greater than 100 units per year with the assumption that higher quantities would compensate for the administrative costs incurred from this process. For items demanded more than 100 times per year, proceed to step six. For those items with less than 100 demands per year, test the unit price.

2. Unit Price

Unit price refers to "...the cost of one spare part to DOD. It is the spare parts' purchase price." Ruth Graham chose a unit price cut off value of $1,000 as she believed this value appeared to be high enough to "...allow for small improvements in life cycle costing to be greater than the increased administrative costs of the spare part procurement." If the spare does not meet this requirement procure the item using normal replenishment processes. If the unit price is greater than $1,000, proceed to step six. [Ref. 9:p. 37]

The user of the model can determine the total cost of the item based on actual demand and price history. The parameter set by Ruth Graham for total cost, $10,000, was arbitrarily set and will be evaluated in Chapter VI during the analysis of the application process.

Demand history can be accessed through file inquiry into the Installation Support Activity Master Data Record. In addition to providing demand history, this file also presents the unit price paid during each acquisition.

In the event there are no historical data available, expected demand can be projected by depot maintenance managers based on historical utilization factors. Additionally, unit price can be estimated through engineering estimates or by soliciting potential vendors.

J. DURABILITY/RELIABILITY

Step Six: Durability/Reliability. Durability refers to "...the effective lifetime of the spare part." [Ref. 4:p. 49] Reliability is the "...probability that an item will perform over some period of time under given conditions." [Ref. 4:p. 39] Ruth Graham believed that the user of the model must be able to determine the durability and reliability measures. If these measures of effective life cannot be determined, the item should be procured using the normal replenishment process. If this measure is known or can be determined, proceed to step seven.

The user of the model has several methods of determining the durability/reliability of an item. The specifications may contain desired measures of durability and reliability. If the specification is not readily available, the user of the model can make an inquiry to the item manager at the NICP for technical assistance. The item manager may be able to determine this information by referring to the specification, inquiry into CCSS cataloging, or by requesting assistance from technical engineers within the NICP. The user of the model may also request assistance from in-house engineers or by requesting the vendor provide the durability/reliability estimate.

K. TECHNICAL DATA

Step Seven: Technical Data refers to the "...availability or necessity of technical data." [Ref. 4:p. 50] Ruth Graham defined technical data as details describing internal, as well as external, design characteristics. [Ref. 4:p. 37]

If technical data are not available on the item being procured and design is important, the item should be acquired using normal replenishment procedures.

If data are available or detailed design not important, the user of the model should proceed to step eight.

The user of the model can determine if technical data are available, if not readily available within the depot, by inquiry into HAYSTACK. HAYSTACK defines the technical characteristics of the item as well as provides information on the availability of applicable specifications and standards. The item managers and logistic engineers can also assist the user in obtaining this information.

L. PERFORMANCE MEASURES

Step Eight: Performance Measures refer to "...how the level of performance is defined and measured." [Ref. 4:p. 38] Ruth Graham determined that if performance measures are not defined and cannot be determined through engineering analysis the acquisition should be made through normal replenishment processes. If the performance measure is known or can be determined, proceed to step nine.

Determining the performance measure to be used, if not readily available, is best accomplished by qualified engineering personnel. Examples of types of performance measures presented by Ruth Graham include [Ref. 4:p. 38]:

1. Work Output per Energy Input (i.e. miles per gallon (MPG)).
2. Mean Time Between Failure (i.e. days to failure (MTBF)).
3. Work Output to Failure (i.e. charge-discharge cycles).
4. Maintainability (i.e. Mean Time to Repair (MTTR)).

Other measures of performance discovered during this research include: Mean Time Between Essential Maintenance Actions (MTBEMA) which indicates the frequency of demand for essential maintenance support, Mean Time Between Operational Mission Failure (MTBOMF) which measures effectiveness to perform mission essential functions, and Mean Time Between Removals (MTBR) which measures the time, cycles, distance, or events during the system life.

In the event performance measures are not known for a particular spare part, the user of the model can make inquiry into the type performance measures used to describe the performance of similar items.

M. PERFORMANCE LEVEL

Step Nine: Performance Levels are defined as "...unambiguous objective factors based on hard historical data." [Ref. 4:p. 38] The performance level is a rating or value based on the performance measure established in Step Eight.

Step nine is the last step in deciding if a repair part will be procured using Life Cycle Costing techniques. If the performance level is not known and cannot be determined or estimated, then the part should be acquired using the normal replenishment process. If the performance level is known or can be determined, proceed to step ten. At this point the spare part is a candidate for procurement using Life Cycle Costing methods and techniques.

N. COST PER LEVEL OF PERFORMANCE

Step Ten: Cost per Level of Performance is determined by "...dividing the unit cost of the spare part by the performance level." Ruth Graham used the following example to illustrate this process. "If a spare part costs $1,000 and its current performance level is 3000 flight hours, then the spare parts cost per level of performance is $.33 per flight hour." [Ref. 4:p. 52]

Once the user of the model has computed the cost per level of performance proceed to the final step in the process.

O. DESIRED COST PER LEVEL OF PERFORMANCE

Step Eleven: The final step in the process is determining the Desired Cost per Level of Performance. The desired cost per level of performance is the figure which will be used during solicitation and source selection. It may be the same value as calculated in Cost per Level of Performance or it may be adjusted based on engineering estimates. [Ref. 4:p. 53]

P. OTHER CHARACTERISTICS

In addition to the characteristics presented in Ruth Graham's thesis, this researcher discovered two other characteristics which may be important in the decision making process within the Sacramento Army Depot.

1. Level of Repair

Determining the level of repair and performing the repair, if in fact the item is repairable, is an alternative to the acquisition process. To be considered the appropriate level of repair all required tools and skills must be available to return the item to a serviceable condition.

The Department of the Army has three levels of Repair: Organizational, Intermediate, and Depot Maintenance. Depot maintenance activities are authorized to perform all levels of maintenance. The procedure for determining the level of repair will differ for part numbered and National Stock Numbered items.

a. Part Numbered Items

The level of repair for part numbered items can be determined by consulting the applicable technical manual or manufacturer's catalog. If the technical manual or other documentation specifies a level of repair, take no procurement actions. In the event the level of repair is not identified, identified as non-repairable, or cannot be determined, proceed with the model.

b. National Stock Numbered Items

The authorized level of repair, for National Stock Numbered items, is designated by the Maintenance Repair Code (MRC). The MRC is found in the Army Master Data File or applicable Army Technical Manual. For MRC's other than Z (Codes O,F,H,D), the item manager should pursue repair instead of procurement processes. For MRC Z (non-repairable), the user should proceed with use of the model.

2. Ascribed Method of Acquisition

The ascribed method of acquisition is a predetermined or assigned procedure/source for acquiring the spare part or item. Repair parts can be acquired by the depot activity from the Army's Supply System, General Supply Activity, Defense Logistics Agency, other military services, or through local procurement.

Manufacturers identify each unique part by assigning a manufacturer's part number. Spare parts that are repetitively procured by the services are assigned National Stock Numbers by the Defense Logistics Agency [Ref. 10:p. 82]. A National Stock Number may be assigned for a single manufacture's part or several different manufacturers' parts that perform the same function. Just as common is the case when National Stock Numbers cross-reference back to other National Stock Numbers. Whatever the case, the preferred method of ordering spare parts is by National Stock Number. Every attempt should be made to cross-reference manufacturer's part numbers to National Stock Numbers. In the event part numbers cannot be cross-referenced to a National Stock Number, the part can be ordered using the manufacturer's part number.

The user of the model must determine the ascribed method of acquiring the repair part. Procedures will vary for part numbered items and National Stock Numbered items.

a. Part Numbered Items

Item managers/purchasing agents must determine if the part number has a predetermined method of acquisition. This determination is based on past procurement experience. If the part has been purchased successfully using Life Cycle Costing in the past or is a first time buy, proceed with the use of the model. In the event Life Cycle Costing has not been used successfully in past procurements (i.e. costs outweigh the benefits of Life Cycle Costing), then acquire the item through normal replenishment processes.

b. National Stock Numbered Items

The item manager within the Depot Inventory Management Division is responsible for adhering to predetermined methods of acquisition for National Stock Numbered items. This process is accomplished by inquiry into the Army Master Data File (AMDF) or HAYSTACK. These data sources list the ascribed method of acquisition: The Acquisition Advice Code (AAC).

The Acquisition Advice Code directs the user as to the method of acquiring the item. Explanations of Acquisition Advice Codes are found in the Defense Logistics Agency's Customer Assistance Handbook and DOD Directive 4100.39M. Acquisition Advice Codes which require acquiring the spare part through other than through the normal depot wholesale supply channels are:

1. AAC I Direct Ordering from a Central Contract
2. AAC K Centrally Stocked Overseas Only
3. AAC L Local Purchase

If the National Stock Number has one of the above Acquisition Advice Codes, proceed with application of the model. Otherwise, acquire the item through normal replenishment processes.

Q. SUMMARY

This chapter provided an explanation and analysis of each criterion in the Graham Decision Model for Spare Parts. The analysis was presented from the perspective of the user at the Sacramento Army Depot. The analysis included identifying the tools and processes the item manager or purchasing agent might use to evaluate each of the model's criterion when acquiring communication and electronic repair parts through the wholesale replenishment system. Following the analysis of the model were two additional criteria the researcher believes to influence the decision process at the Sacramento Army Depot. The following chapter demonstrates the application of the model, including the two additional criteria, to selected communication and electronic repair parts.

V. DEMONSTRATION OF MODEL TO SELECTED REPAIR PARTS

A. INTRODUCTION

This Chapter demonstrates the application of the Graham Decision Model for Spare Parts to the acquisition of communication and electronic repair parts at the Sacramento Army Depot. The application of the model is presented from the perspective of the item manager and the purchasing agent to fully evaluate the applicability of the model to the depot wholesale replenishment process. The researcher will then evaluate the communication and electronic repair part candidates using the two characteristics--Level of Repair and Ascribed Method of Acquisition, proposed at the end of Chapter IV.

The researcher believes the repair parts selected to demonstrate the model are fair representatives of the types of communication and electronic spare parts routinely requisitioned by the depot maintenance activities and purchased by the Purchasing Division. A complete listing of the repair parts and selected data are enclosed in Appendix B.

B. APPLICATION OF THE MODEL

The researcher conducted the step-by-step application of the decision model to 50 selected communication and electronic repair parts. The information required to complete the application process came from inquiry into the Installation Support Master Data File, Supply Management Information Data Base, HAYSTACK, Army Master Data File, and through technical assistance from supporting National

Inventory Control Point's (NICP's) item managers and logistic engineers. The specific source used to obtain necessary information will be identified in each step of the application process.

1. Step One

Is the buy to fill an urgent requirement?

Urgent requirements are identified in the requisition document, by the requiring activity, by Priority Designator 03. On an average ten percent of all requisitions passed into Depot Property (Directorate of Supply) are to fill urgent requirements. This ten percent of requisitions would fall out of the decision process and be acquired through normal replenishment processes. The remaining 90 percent of requisitions are to fulfill normal replenishment or routine requirements, which include normal stockage and deferred maintenance actions. These 90 percent of the requisitions would proceed to step two of the decision process.

The repair parts used to test the decision model were selected randomly and are considered a fair representation of communication and electronic repair parts. As a result, they may or may not reflect a current requirement at the depot activity. However, based on supply history it can be expected that approximately ten percent of the repair parts considered would be to fulfill urgent requirements and would fall out of the decision process. The remaining 90 percent would proceed in the decision process. Since it is not reasonable to assume which communication and electronic repair parts would fill the ten percent urgent requirements, all 50 communication and electronic repair parts will be considered in step two.

2. Step Two

Does the shelf life allow for Life Cycle Cost procurement?

Shelf life items with a shelf life of six months or less do not pass this selection criteria and are acquired through normal replenishment processes. Of the 50 communication and electronic repair parts tested in the decision model, 46 do not have a shelf life and are considered non-deteriorative. The remaining four repair parts are batteries used in communication and electronic systems with shelf lives of greater than six months. One with a shelf life of 24 months (Type II), two with shelf lives of 36 months (Type II), and one with a shelf life of 48 months (Type II).

All 50 communication and electronic repair parts successfully passed step two of the decision process and will proceed to step three. The shelf life information was obtained through inquiry to HAYSTACK.

3. Step Three

Is competition available?

The lack of adequate competition causes a repair part to be rejected from the decision process and be acquired through normal replenishment processes. All 50 communication and electronic repair parts made it to step three in the process. However, of these 50 repair parts, six currently lack recorded alternate sources (competition) and do not pass this step in the decision process. Historical records at the inventory control point indicate the purchases for these six items have been made through a single source since the fielding of the communication and electronic system. The researcher was unable to determine if in fact potential sources may exist for supply and manufacturing of these repair parts. The item manager can determine if potential sources exist through the next solicitation by using design or functional type specifications in the Invitation for Bid (IFB) or Request for Proposal (RFP).

Competition exists for the remaining 44 communication and electronic repair parts and will be considered in step four. The determination for available competition was made based upon depot purchasing history and alternate sources currently documented in HAYSTACK.

4. Step Four

Is the item of a mature design?

The design must be stable in order to benefit from Life Cycle Costing. In the event the repair part is not of a mature design, acquire the item using normal replenishment processes. Of the 44 communication and electronic repair parts considered in this step, all 44 have confirmed mature designs. Therefore, all 44 repair parts will proceed to step five of the decision process.

The maturity of design was verified through inquiry to the National Inventory Control Point item managers, logistic engineers, and reference to applicable technical manuals.

5. Step Five

Is the total cost of procurement greater than $10,000?

Total cost of procurement is determined by multiplying the quantity ordered times the unit price. In the event the total cost of a particular repair part is greater than $10,000, proceed to step six of the decision process. Only one communication and electronic repair part has a total cost of procurement greater than $10,000. This repair part proceeds to step six in the decision process.

The remaining 43 communication and electronic repair parts must be tested for demand and, if necessary, unit price. The $10,000 was an arbitrary value selected by Ruth Graham and will be analyzed following the demonstration of the model. The total cost for each communication and electronic repair part was determined through inquiry into the Installation Support Activity Master Data Record.

a. Step 5.1

Is the demand greater than 100 units per year?

Repair parts with a total demand of greater than 100 per year proceed to step six in the decision process. The repair parts that do not meet this criterion are tested for unit price.

Of the 43 communication and electronic repair parts not meeting the total cost criteria, 32 have a total yearly demand of 100 or greater and proceed to step six of the decision process. The unit price must now be tested for the other 11 repair parts. Information on total demands per year were obtained through inquiry to the Installation Support Activity Master Data Record.

b. Step 5.2

Is the unit price greater than $1,000?

The unit price, according to Ruth Graham, must be greater than $1,000 in order to benefit from Life Cycle Costing. Of the 11 communication and electronic repair parts considered in this step, all 11 repair parts fail the unit price criterion . These 11 communication and electronic repair parts are eliminated from the decision process and are acquired using normal replenishment processes. Information on unit price was obtained through inquiry into the Installational Support Activity Master Data Record.

6. Step Six

Is current durability/reliability known?

Current durability/reliability is basically the effective life of that repair part. At this point, 33 communication and electronic repair parts of the 50 original repair parts have successfully passed the criteria in the decision process. However, at step six the remaining 33 communication and electronic repair parts are rejected from the decision process for lack of available durability/reliability measures.

Durability/reliability information could not be obtained for any of the 50 communication and electronic repair parts tested in the model. Specifications were not available at the depot activity for any repair parts. The researcher requested technical assistance from item managers at the respective inventory control points. Without exception, the item managers referred the researcher to logistic engineers for technical support. The researcher requested technical assistance from logistic engineers at the Defense Electronics Supply Center (DESC), Defense Industrial Supply Center (DISC) and United States Army Communication and Electronics Command (CECOM). The logistic engineers consulted their data bases and applicable specifications. The data base, Commodity Command Standard System, did not contain the data to make durability/reliability determinations. In addition, the applicable specifications did not call out durability/reliability requirements for any of the selected repair parts.

The decision process then led the researcher to assess whether or not durability/reliability measures could be determined within the depot maintenance activity. The researcher then evaluated the depot maintenance and usage data in order to determine if adequate information was available to determine durability/reliability measures. The Maintenance Stock Item Report Inquiry proved to only reflect the depot overhaul factors. Depot overhaul factors reflect the quantity usage for each repair part used in overhaul, rebuild or repair of communication and electronic commodity items. For example, a depot overhaul factor of .20 means that for every 100 items overhauled, rebuilt, or repaired, 20 will require replacement of that particular item.

At this point the user of the model would acquire the remaining 32 communication and electronic repair parts, rejected for Life Cycle Costing, using normal replenishment processes. However, for this thesis, the researcher will proceed with the application process in order to later assess the impact of this step in the sequencing of the criteria.

7. Step Seven

Are technical data available?

This step in the decision process evaluates the availability and applicability of technical data in the procurement of a repair part. All 33 communication and electronic repair parts that successfully passed steps one through six were considered in step seven of the decision process.

All 33 communication and electronic repair parts considered in this step, just as the 17 repair parts previously rejected, have technical data, drawings, or specifications. All 33 communication and electronic repair parts proceed to the next step of the decision process.

Availability of technical data was determined by consulting the applicable technical manuals for drawings or required specifications, inquiry into HAYSTACK, and through technical assistance from the logistic engineers at the National Inventory Control Points. Specifications for selected spares were found in both military and commercial form.

8. Step Eight

Are performance measures defined?

This step in the decision process requires the user of the model to determine if performance measures are currently defined or can they be reasonably defined. For those items which have a definable performance measure, proceed to step nine.

Performance measures for communication and electronic repair parts were not available within the depot activity. The researcher then requested technical assistance from logistic engineers at the three inventory control points. All three logistic engineers responded that this information was not available within the specification or standard, and was not determinable from information in the data base. One logistic engineer, from the Defense Electronics Supply Center, forwarded "hard-copy" output from the research process. The logistic engineer made inquiry into the Total Item Record, Commodity Command Standard System, and applicable standards and specifications. The end result of his efforts showed the information needed in order to define performance measures, and subsequently performance levels, was not available in the various sources. [Ref 17]

At this point in the decision process the user of the model has no other alternative other than to procure the repair parts through normal replenishment processes.

9. Step Nine

Are current performance levels known?

As a result of performance measures not being known or determinable in step eight of the decision process, the researcher could not obtain any performance levels for any of the 50 communication and electronic spare part candidates. In addition, the logistic engineers at the various inventory control points did not have the data base or information available to determine appropriate performance levels.

10. Step Ten

Determine cost per level of performance.

This process involves dividing the cost per unit of a repair part by the performance level. The researcher could not perform this step in the decision process as all communication and electronic repair part candidates dropped out of the decision process at step eight.

11. Determine the desired cost per level of performance

The researcher could not perform this step in the process. The non-availability of performance measures and performance levels preclude the researcher from identifying any candidates for Life Cycle Costing.

C. OTHER CHARACTERISTICS

Both characteristics, Level of Repair and Ascribed Method of Acquisition, proposed by the researcher are concerned with alternatives to the procurement process. In keeping with the methodology established by Ruth Graham, the two new criteria will precede the model as developed. Ruth Graham believed the characteristics easiest to identify should be considered first, while more difficult criteria considered last, thereby reducing the workload of the user as repair parts that are not viable candidates for Life Cycle Costing will be eliminated early from the decision process.

1. Level of Repair

This step requires the user of the model to determine if the unserviceable repair part is, in fact, on hand and repairable at the depot activity. This step should be considered before all others as only those parts which are non-repairable or not repairable at the depot activity would proceed to the next step in the decision process.

Of the 50 communication and electronic repair parts considered in the application process, all are non-repairable. Therefore, all 50 repair parts proceed to the evaluation of ascribed method of acquisition step. The level of repair for each repair part was determined through inquiry into the Army Master Data File.

2. Ascribed Method of Acquisition

This step could not be fully evaluated because the selection process for determining the 50 communication and electronic repair parts was strictly based on usage. These items are commonly used throughout the repair, overhaul, and rebuild of communication and electronic systems and therefore, all have assigned National Stock Numbers. All of these items have an ascribed method of acquisition or Acquisition Advice Code (AAC). This step was not tested using part numbered items.

Of the 50 communication and electronic repair parts considered in this step, 46 are Department of Defense stocked and would be ordered through the standard wholesale system using the Standard Depot System. Of the four repair parts with special acquisition instructions: one was AAC Y--terminal item and future purchases not authorized, one AAC V--terminal item that is stocked but future purchases not authorized, and two with AAC Z--insurance/numeric stockage item centrally managed and may be purchased if stocks are not available at the inventory control point.

At this point, all 50 communication and electronic repair parts would be requisitioned through normal wholesale replenishment processes. In the event the item manager at the inventory control point is not able to fill the requirement, purchasing action may be accomplished at the depot level.

D. SUMMARY

This chapter demonstrates the application of 50 selected communication and electronic repair parts to the Graham Decision Model for Spare Parts. All information and sources of information available to the item manager and purchasing agent were considered by the researcher in the application process. The following chapter presents an analysis of the application of the Graham Decision Model for Spare Parts to the Sacramento Army Depot.

VI. ANALYSIS

A. INTRODUCTION

This chapter presents an analysis of the information and data presented in Chapters III, IV, and V. The chapter begins with an analysis of Life Cycle Costing within the wholesale replenishment process. It then moves to an analysis of Life Cycle Costing within the Directorate of Contracting, Sacramento Army Depot. Finally, an analysis is presented of the application of 50 selected communication and electronic repair parts to the Graham Decision Model for Spare Parts.

B. LIFE CYCLE COSTING AND WHOLESALE REPLENISHMENT

Life Cycle Costs were defined as the total cost of acquiring, operating, supporting, and disposing of an item or system. Of these, operating and support costs have the greatest impact on Life Cycle Costs. Operating and support costs include costs of fuel, maintenance, provisioning, support equipment, technical manuals and other operating support. This thesis is concerned with the maintenance and other operating support costs: replenishment. The Army's Competition Advocate Office reports that approximately $2.2 Billion is spent annually in the replenishment process for the Department of the Army.

The most common Life Cycle Cost factors, often referred to as cost drivers, encountered in repair parts procurements were performance, technology, and durability/reliability. This researcher observed significant relationships in the definitions of durability/reliability and performance levels. Durability/reliability deal with the effective lifetime and expected performance over a period of time. Performance measures and performance levels generally deal with measures of time, distance, or events during the items lifetime. For example if a resistor has an electrical resistance of 620 OHMS, and operates in a system for which it was designed, it may be expected that it will perform approximately 200 hours. In this example the durability/reliability measure, just as the performance level, would be 200 hours. The distinction would be how the 200 hours is defined, i.e. 200 hours between failure, or 200 hours between replacement, etc.. The performance measures of each part or component of a system affect the performance of that system. If all repair parts have high durability/reliability measures, it appears that the systems life is extended. This concept is the premise for Life Cycle Costing as discussed in Chapter II. The expectations are with increased durability, reliability, and performance the failure rates and time between maintenance actions are significantly increased, thereby frequency of repair actions are reduced as well as operating and support costs reduced. This is the objective of the Life Cycle Cost policy within the Department of Defense.

The Commodity Command Standard System (CCSS), an automated management system of secondary items and repair parts, is used by Army Material Command in the provisioning and replenishment of repair parts. The Commodity Command Standard System is a demand based system. Functional areas within CCSS use integrated data files and programs to determine the optimal levels for provisioning and replenishment. The Automated Requirements Computation System, part of the Commodity Command Standard System (CCSS), primarily uses two major files for stockage level calculations, Provisioning Master Record (PMR) file and the End Item Parameter (EIP) file, to perform the provisioning function within CCSS. The data which are used in these two files include usage data, replacement rates, and unit price. Usage data are both historical and projected usage. These historical records are accessed within CCSS, along with the Demand Return Disposal (DRD) file, to later compute replenishment quantities. The DRD file maintains data on requisitions and disposal actions from the field. The DRD file is used to compute average monthly demand rates and project future stockage and usage quantities.

The researcher did not find integration or any link between the Life Cycle Cost factors for repair parts and the wholesale replenishment process.

The Sacramento Army Depot integrates with the Army's wholesale system through the Standard Depot System. The Standard Depot System (SDS) is an automated data processing system used throughout the 12 Army Depots and ten Depot Activities. SDS is also a demand based system. SDS is used by functional areas within the depot for inventory, maintenance production control, and resource management. The primary considerations in the replenishment processes performed by SDS are usage data and consumption rates. Again, the researcher could find no integration of replenishment considerations and Life Cycle Cost factors in the wholesale replenishment process of SDS.

C. LIFE CYCLE COSTING AND SACRAMENTO ARMY DEPOT

The researcher conducted interviews with the purchasing agents within the Purchasing Division in order to obtain information on the kinds of Life Cycle Costing factors and principles used in the acquisition of communication and electronic repair parts. Interviews showed that the primary consideration in contract award is purchase price. The policy on purchase price centers around two concepts. First, assuming a competitive buy exists, the lowest responsible and responsive offeror is awarded the contract. Second, in the event the item has been purchased in the past (must be at least one year ago) a price increase of less than 25% from the last purchase is often considered reasonable.

The preferred method of award was Blanket Purchase Agreements (BPAs) using existing sources. Preparing and administering Blanket Purchase Agreements costs about $25.00, while it was estimated a separate contract costs approximately ten times that amount ($250.00).

Purchasing agents find themselves purchasing communication and electronic repair parts with very technical specifications. They indicated that more often than not the communication and electronic repair part was available commercially or interchangeable with a commercial product. They also indicated that many times the communication and electronic repair parts being purchased are commonly obsolete in the commercial market. This is consistent with the repair mission of Sacramento Army Depot, as the depot is mostly involved in the overhaul and rebuild of older Army communication and electronic commodity items.

The purchasing agents were not aware of any Life Cycle Costing principles, methodologies, or techniques. Nor does the Purchasing Division have a Life Cycle Costing policy. During the interviews with the purchasing agents the researcher explained the Life Cycle Cost concept and most indicated the concept made sense and would likely benefit the activity.

Item managers within the Directorate of Supply, Sacramento Army Depot, handle approximately 22,500 requisitions per quarter. Third Quarter, Fiscal Year 1989, statistics show that 18% of all requisitions from the maintenance activities were referred to the Directorate of Contracting for either small purchase, under $25,000, or contracting, over $25,000. In Fiscal Year 1989 the Purchasing Division made a total of 15,567 purchase actions at $36.5 Million. Of this total volume, 2,557 actions were for the Directorate of Maintenance at a dollar value of $27.7 Million. It is clear here that the Directorate of Maintenance, while only comprising 16.4% of the volume of purchasing actions, is the largest customer in dollar volume at 75% of total dollars expended. The arithmetic average of the total purchase price per purchasing action for the Directorate of Maintenance is $10,833. The researcher was unable to obtain what portion of these purchases were made using existing BPA's or separate contracts.

D. THE DECISION MODEL AND APPLICATION PROCESS

The researcher was unable to successfully complete the application of the Graham Decision Model for Spare Parts to any of the 50 selected communication and electronic repair parts with the information currently available to the item manager/purchasing agent, or through technical assistance from the inventory control points.

Steps one through five of the decision model were completed with a relatively simple effort and in a short period of time for each of the 50 selected communication and electronic repair parts. This information came from the Army

Master Data File, HAYSTACK, Installation Support Activity Master Data File, and technical assistance from logistic engineers at the inventory control points.

The researcher selected the 50 communication and electronic repair part candidates for testing the decision model. Therefore, the repair parts did not reflect an actual depot requirement. The researcher allowed all 50 repair parts to proceed to step two of the decision process, as it would not be reasonable to assume which repair parts would fill an urgent requirement. In actual usage of the decision model the Priority Designator 03 would indicate an urgent requirement, while Priority Designators 06 and 13 indicate non-urgent requirements.

Steps two through four required the researcher to make inquiry into HAYSTACK and consult logistic engineers at the applicable inventory control point. All 50 communication and electronic repair parts met the shelf life requirement in step two. A shelf life of greater than six months appears to be reasonable as the decision process could likely take up to six months to complete. However at step three, only 44 of the 50 communication and electronic repair parts have alternate sources and competition available. Only these 44 communication and electronic repair parts proceeded to step four in the decision process.

The Sacramento Army Depot is involved in the repair, rebuild, and overhaul of communication and electronic systems. The very nature of this type work infers the end items tend to be of older items in the Army inventory. The researcher, therefore, was not surprised that all 50 communication and electronic repair parts also were of mature design. However, only the 44 repair parts successfully passing steps two, three, and four proceeded to step five in the decision process.

Step five, total cost greater than $10,000, was the only step that requires any calculation on the part of the user to this point. Step five involved determining the total cost for each repair part procurement action. Total cost is determined by multiplying the quantity demanded and the unit price for each communication and electronic repair part. Upon completion of step five, only 32 of the 50 communication and electronic repair parts were still candidates for Life Cycle Costing. Of the 44 repair parts considered in step five, one successfully passed the $10,000 criterion. This step, of course, is based on an arbitrary figure used to test the model. Under normal circumstances that figure could be changed if lower dollar items were to be purchased under Life Cycle Costing considerations. The other 43 were tested for demand and unit price. The demand must be greater than 100 per year in order to proceed to step six. Only 32 of those considered had a total demand greater than 100. The remaining 11 communication and electronic repair parts were rejected as candidates for Life Cycle Costing as they failed to meet both the demand and unit price criteria of $1,000.

At this point, 32 communication and electronic repair parts remained as candidates for Life Cycle Costing and proceeded to step six in the decision process. Statistics from the Purchasing Division show the average total purchase price for purchases made for the Directorate of Maintenance average about $10,833. This average purchase price is very close to the arbitrary value, $10,000, established by Ruth Graham for the total cost criterion. The researcher was unable to determine the average unit price, per item, purchased by the division. Therefore, it is difficult to analyze the $1,000 per unit floor, established by Ruth Graham, as the level where benefits exceed the costs of administering Life Cycle Costing. However, the purchasing agents claim that it costs $250 to prepare a contract. The researcher estimates it would take the purchasing agent two times as long to complete an award using Life Cycle Costing. Therefore, perhaps the unit price may have to only exceed $500 as a floor at Sacramento Army Depot. This estimate is based on the additional effort and time required to obtain Life Cycle Costing information and to administer the model. Additionally, this estimate is consistent with Ruth Graham's six month criteria as the time required to administer the model. The floor for unit cost should not be set arbitrarily at a specific dollar amount. The unique aspect of each contracting or purchasing activity operation will dictate what the value should be in order to obtain maximum benefit from Life Cycle Costing.

Step six required the researcher to determine if durability/reliability measures were known for each communication and electronic repair part still a candidate for Life Cycle Costing. Of the 32 repair parts considered at this step, all failed to meet this requirement. Durability/reliability measures were not available or determinable with information available at the Sacramento Army Depot or through the wholesale inventory system. The researcher requested technical assistance from the three National Inventory Control Points (NICP's) responsible for inventory management of the repair part candidates. Durability and reliability measures were not determinable at the NICP by logistic engineers. A further discussion of durability/reliability measures are presented with the analysis of performance levels.

At this point in the decision process all 50 communication and electronic repair parts were eliminated from the decision model and were not considered candidates for Life Cycle Costing based on the model's criteria. However, the researcher continued to pursue the application of the decision model with the remaining 32 communication and electronic repair parts in order to fully assess the impact of the sequencing decision made by Ruth Graham in the development of the model.

Step seven was concerned with the availability of technical data and specifications. As previously described the Sacramento Army Depot overhauls and rebuilds the Army's older communication equipment. Therefore, all 32 communication and electronic repair parts did have established drawings or specifications. Specifications were in the form of Federal, military, and commercial specifications. All 32 repair parts passed this selection criterion and proceeded to step eight in the decision process.

Step eight involved defining the performance measures for each repair part candidate. Performance measures were not available or determinable within the depot activity. The researcher then requested technical assistance from the item managers and logistic engineers at the NICPs. This information was requested at the same time the researcher requested durability/reliability measures. In addition, the researcher also requested the performance level if known, and technical assistance for establishing performance measures and performance levels if unknown. The logistic engineers at all three NICPs were unable to find or determine a single performance measure or performance level.

The researcher expected that performance measures and levels would be established or determinable at the inventory control points responsible for the centralized management for each commodity item. However, the item managers indicated durability/reliability and performance measures were not defined in any of the specifications and the data base did not contain the information necessary to make the determination.

Based on conversations with various program managers and item managers at the Inventory Control Points, it appears when systems are purchased Life Cycle Cost considerations are made only at the system level, vice for individual repair parts and secondary items that comprise the system. The item manager does not have access to a data base that describes repair parts by expected or predetermined performance measures, nor is the information available to determine Life Cycle Costing parameters.

At this point, the researcher could no longer proceed with the assessment and application of the Graham Decision Model for Spare Parts. Steps nine, ten and eleven deal directly with established performance levels.

Step nine was to determine if a performance level exists. The procedures and desired information for this step in the decision process were the same for completing step six in the process: Determining durability/reliability measures. Step ten involves determining a cost per level of performance and step eleven is determining a desired cost per level of performance.

E. ANALYSIS OF RESEARCHER'S PROPOSED CRITERIA

As explained in Chapter V, the researcher would consider the two criteria, Level of Repair and Ascribed Method of Acquisition respectively, prior to considering step one in the decision model. The researcher placed the two characteristics in front of the existing model as they lead to alternatives other than the procurement process.

Of the 50 communication and electronic repair parts evaluated for Level of Repair, all 50 were not repairable. Therefore, the researcher proceeded to the next step in the process: Ascribed Method of Acquisition. Had any of the selected repair parts been repairable at the depot activity, work orders for item repair would be initiated. This process would reduce the workload of the user and would likely provide cost savings to the depot activity.

The Ascribed Method of Acquisition also provides alternatives to the procurement process. As previously explained, all 50 communication and electronic repair parts have assigned National Stock Numbers. This skews the results as it would be expected that approximately 18% of the repair parts tested would recommend or direct local purchase action. Of the 50 repair parts, 46 have an ascribed method of acquisition which directs replenishment through normal replenishment processes. The remaining four have special instructions: two of which can not be locally purchased as they are terminal items, and two repair parts which may be locally purchased only following purchasing instructions from the inventory control point. In the event the repair part candidates had an Acquisition Advice Code which directed local procurement, the user of the model would have proceeded with step one in the decision process as developed by Ruth Graham.

Early identification of repair parts which are not permitted to be purchased will significantly reduce the workload of the purchasing agent as these repair parts will not be considered in the decision process.

F. SUMMARY

This chapter presented an analysis of Life Cycle Costing and the wholesale replenishment inventory process. It also provides an analysis of Life Cycle Cost within the Purchasing Division, Sacramento Army Depot. An analysis was then presented on the application of the Graham Decision Model for Spare Parts to 50 selected communication and electronic repair parts. These repair parts represent the types of communication and electronic parts routinely handled by the Sacramento Army Depot Purchasing Division. Finally, an analysis was presented on the impact of the two additional criteria, proposed by this researcher, to the application of the decision model to the Sacramento Army Depot.

VII. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

The purpose of this thesis was to study the application of the Graham Decision Model for Spare Parts for communication and electronic repair parts within the Purchasing Division, Directorate, Sacramento Army Depot, United States Army Depot Systems Command.

The Graham Decision Model for Spare Parts was designed to assist the item manager/purchasing agent in identifying repair parts as candidates for Life Cycle Costing methods and techniques.

To evaluate the application of the model, the researcher reviewed the evolution of Life Cycle Costing, the Army's wholesale replenishment inventory system, and the functional areas within the depot activity involved in the acquisition of repair parts. Chapter IV reviewed the Graham Decision Model for Spare Parts and defined each criterion as it pertained to the replenishment process at the Sacramento Army Depot. Chapter V demonstrated the application process, as developed by Ruth Graham, to communication and electronic repair parts. Chapter VI provided an analysis of Life Cycle Costing and the Army's wholesale replenishment system from the National Inventory Control Point to Depot level. Chapter VI then presented an analysis and assessment of the application of 50 selected communication and electronic repair parts to the Graham Decision Model for Spare Parts.

In this chapter the researcher presents thesis conclusions and recommendations. It also answers the primary and subsidiary research questions posed in Chapter I. As a result, the researcher proposes modifications to the decision model and wholesale replenishment process for application of Life Cycle Costing techniques in repair parts procurement.

B. CONCLUSIONS

1. Life Cycle Costing techniques and methodologies are not currently being employed at the Sacramento Army Depot in the replenishment of repair parts.

Interviews with the purchasing agents revealed that Life Cycle Costing methodologies and techniques are not being used in the procurement of communication and electronic repair parts. The replenishment process at depot level is demand based. Therefore, the purchasing agent buys only to fill the requirement without making a Life Cycle Cost determination or considering the potential benefits of using Life Cycle Costing techniques. The purchasing agent's primary consideration for contract award is purchase price. The purchase agents attempt to award the contract to the lowest responsive and responsible offeror. Additionally, when possible, purchases are made on existing Blanket Purchase Agreements.

2. The Department of the Army wholesale inventory replenishment system is demand based and does not consider Life Cycle Costing.

The Commodity Command Standard System (CCSS) and Standard Depot System (SDS) are strictly demand based systems which calculate the quantity of items needed to fulfill average monthly demand rates and any projected requirements.

CCSS does not gather failure data nor does the program office gather information necessary to make durability/reliability estimates or determine performance levels for use in the replenishment process. As the system currently exists, there is not a data base available to depot item managers or purchasing agents to determine adequate performance measures or performance levels for repair parts currently in the inventory system.

3. <u>The Graham Decision Model for Spare Parts cannot yet be effectively applied to the depot wholesale replenishment process</u>.

As demonstrated in Chapter V, the Graham Decision Model for Spare Parts cannot be effectively applied to the replenishment of communication and electronic spares because the system is purely demand based. The Life Cycle Cost considerations include other factors, such as durability and performance measures, which are not currently available to the Buyer when attempting to apply the model at the depot wholesale inventory level.

The researcher does believe, however, that the Graham Decision Model for Spare Parts is applicable, but would require some modifications to the replenishment processes. The program offices responsible for fielding a communication or electronic system must require accurate performance measures and performance levels from the contractor. As the system currently exists, the overall reliability of the system is measured to determine optimal availability. Initial provisioning, and subsequent replenishment, stockages are based on projected usage or historical demand rates. There are no considerations towards identifying potential cost savings through improved performance or individual repair parts and components.

This study did not evaluate the net result of the prospective savings from using Life Cycle Costing techniques and the prospectively higher acquisition costs of administering the decision model. One might argue that the logic behind the structure of the decision model is flawed in that by considering those criteria easiest to identify first may unduly eliminate repair parts which potentially possess significant savings through Life Cycle Costing. The originator of the model intended, through the structure of the model, to focus management efforts to those acquisitions which potentially yield the highest savings through Life Cycle Costing.

The researcher found those criteria considered in the first five steps of the decision process easily determined by referring to recorded information or through minor calculations. It may perhaps be premature to eliminate a repair part as a candidate for Life Cycle Costing so early in the decision process. Perhaps only six, seven or eight of the first nine criteria should be met in order to proceed with Life Cycle Costing. The objective of Life Cycle Costing in repair parts acquisition is to enhance the performance of the system by increasing the reliability and durability of the components that make up the system. These performance criteria and measures of utility are not evaluated until the latter stages in the decision process.

4. <u>Repair parts procurement is a viable consideration for cost savings through Life Cycle Costing</u>.

The Department of the Army currently spends about $2.2 Billion annually in the replenishment of repair parts in support of vehicles and equipment. As the replenishment system currently exists, these expenditures are being made against projected demand and actual usage data. The Life Cycle Cost concept for repair parts implies that a part is purchased on the basis of a measure of utility. In order for a benefit to be realized, the cost savings must be greater than the difference between the price paid for higher performance level and that of what is currently paid. The benefits or cost savings are also realized in terms of greater reliability of equipment, longer periods of operational availability (i.e. extended Mean Time Between Failure (MTBF)), fewer maintenance actions, and reduced quantities of each repair part purchased over a period of time.

The potential savings through Life Cycle Costing exists, however, the repair parts provisioning and replenishment processes must be modified in order to realize these savings.

C. RECOMMENDATIONS

1. Educate the purchasing agents in Life Cycle Costing methodologies and techniques.

The researcher believes there are significant benefits to Life Cycle Costing. The purchasing agents should consider more than the price of the acquisition in source selection. With an average total purchase price of $10,833, per order, for the Directorate of Maintenance, the potential savings over the effective lifetime of a piece of equipment can be significant.

The purchasing agents should be trained in performing Life Cycle Cost estimating techniques for preparing and awarding contracts. The purchasing agent can begin using Life Cycle Costing methodologies in preparing solicitation documents by identifying Life Cycle Cost and performance requirements as source selection criteria. In addition, the contractor should be required to verify performance data prior to contract award.

2. Require that all Army Material Command Major Subordinate Commands consider Life Cycle Costing.

Require that all Major Subordinate Commands (MSCs) consider Life Cycle Costing in the selection of contractors, both during the provisioning and replenishment processes, for their respective commodity items. In addition, require Major Subordinate Commands to maintain appropriate performance data during the research and development, demonstration validation, and production phases of the acquisition cycle. These data should be collected and stored in the Commodity Command Standard System and continually updated following test and evaluation, and again following actual performance measures determinable through field use. In a decade where military expenditures are rapidly declining, the cost per measure of utility becomes increasingly important as increased Mean Time Between Failures (MTBF's) lead to longer serviceability and less repair/maintenance costs.

3. Army Material Command conduct a study of the impact of Life Cycle Costing to the procurement of repair parts in both initial provisioning and follow on replenishment.

Life Cycle Costing for repair parts is not currently being considered during system acquisition and subsequent replenishment. Program offices are not involved in the analysis of potential benefits of Life Cycle Costing at repair part and secondary item level. The program offices use the Commodity Command Standard

System (CCSS) and other integrated computer programs to access operational availability and project stockage quantities based on usage and demand data. This is not Life Cycle Costing.

Program managers and item managers must have a data base accessible in order to record and retrieve performance data in order to make Life Cycle Costing decisions.

This study should assess the potential savings of Life Cycle Costing for repair parts and work to develop an automated data base, or modify the existing CCSS, in order to assist the decision maker in making Life Cycle Cost considerations.

D. ANSWERS TO SUBSIDIARY RESEARCH QUESTIONS

1. What are communication and electronic repair parts?

Communication and electronic repair parts are consumable, non-repairable, and repairable sub-components, components, sub-assemblies, or assemblies used to return, through repair and replacement, the following type systems to serviceable condition: tactical and non-tactical computers, night vision/thermal imagery devices, lasers, electronic and signal warfare systems, tactical and non-tactical communication/radio systems, aviation electronics and instruments, target acquisition equipment, radar, meteorological equipment, tactical and non-tactical television equipment, facsimile equipment, audio visual and sound recording equipment, transportable ground/air/vehicular shelters, and communication and electronic test equipment.

2. <u>What are the unique Life Cycle Cost aspects of communication and electronic repair parts</u>?

The researcher did not identify any Life Cycle Cost principles or characteristics unique to only communication and electronic repair parts. Repair parts in general, as described by Ruth Graham, display inherent characteristics that make them suitable for Life Cycle Costing. However, this researcher found that specification and level of technology were most critical in Life Cycle Costing for communication and electronic repair parts.

Communication and electronic repair parts had predominantly performance specifications, as opposed to design specifications. The purchasing agents were more likely to use form, fit and function (F^3) requirements in solicitation of communication and electronic repair parts. This type solicitation encourages competition and tends to lead to higher performance and reliability.

Level of technology, or maturity as identified by Ruth Graham, is also an important consideration in Life Cycle Costing for communication and electronic repair parts. State-of-the-art designs for communication and electronic repair parts are not well suited for Life Cycle Costing. State-of-the-art items are characterized by evolutionary design and engineering. Communication and electronic items with well defined and understood technology are better suited for Life Cycle Costing and have established performance and usage data.

3. <u>How might the Graham Decision Model for Spare Parts be refined and improved for procurement of communication and electronic repair parts</u>?

The Graham Decision Model for Spare Parts could not be fully assessed in this research effort as the Army's wholesale system does not have a sufficient enough data base to make Life Cycle Costing decisions. The researcher has laid out the foundation of what must be done in order for the Army Material Command to begin using Life Cycle Costing in the acquisition of repair parts both during initial provisioning and subsequent replenishment. Until a data base is established within the wholesale system, the decision model can not be effectively applied to the replenishment process. However, the researcher believes several adjustments should be made to the decision model to make the decision process more usable and efficient to the item manager/purchasing agent at Sacramento Army Depot, thereby reducing the costs of administering the model while increasing the net benefits of Life Cycle Costing.

Prior to considering procurement of the repair part, the user of the model should determine if the item is repairable at the depot activity. If the item is repairable at the activity, as designated by the Level of Repair, pursue maintenance actions. If the repair part is not repairable consider the ascribed method of acquisition. The decision to repair an item with "in-house" capability is an economic decision, as well as a production decision. The potential cost savings through repair at the depot activity may serve to reduce the costs of supporting the end item and ultimately reduce the Life Cycle Costs of the weapon system.

The researcher recommends considering the ascribed method of acquisition prior to engaging in application of the model. The ascribed method of acquisition may restrict the user of the model to a designated method of acquiring the repair part. The past purchasing history of using Life Cycle Cost methods or techniques will dictate to continue using Life Cycle Costing, or if not cost beneficial, recommend acquisition through normal replenishment processes. In the event the ascribed method of acquisition is local procurement, proceed with step one in the Graham Decision Model for Spare Parts. Otherwise, follow the ascribed method of acquisition and procure through normal replenishment processes.

The researcher also recommends that steps six, eight, and nine be combined into a single step and follow the determination of availability of technical data. All other sequencing would remain unchanged.

The researcher discovered while trying to identify durability/reliability, performance measures, and performance levels the approach and research effort were identical. The researcher proposes that combining these steps into a single step, and sequencing this step following the determination of technical data, would increase the efficiency of the model. The combined steps six, eight, and nine could be designated as simply Demonstrated Performance Level. Appendix C illustrates the proposed modification to the Graham Decision Model for Spare Parts for use by the Purchasing Division at the Sacramento Army Depot, Depot Systems Command.

E. ANSWER TO PRIMARY RESEARCH QUESTION

How might the Graham Decision Model for Spare Parts be applied to the procurement of communication and electronic spare parts in the Purchasing Division, Directorate of Contracting, of the Sacramento Army Depot?

The Graham Decision Model for Spare Parts was designed to identify repair parts as candidates for procurement using Life Cycle Costing methods and techniques. It was made apparent in Chapter V that the decision model could not be fully applied with the information currently available to the user within the Sacramento Army Depot or the wholesale replenishment system. The researcher was unable to fully assess the model to the wholesale replenishment process. However, the researcher does believe the model is applicable to communication and electronic repair parts. The Life Cycle Cost aspects, previously discussed, make communication and electronic repair parts candidates for Life Cycle Costing methods and techniques with significant potential savings.

Army Material Command must however modify the Commodity Command Standard System to properly record performance levels for later use in Life Cycle Costing for replenishment of repair parts. Currently there is little consideration given to Life Cycle Costing for repair parts in the wholesale supply system. Initial provisioning and subsequent replenishment decisions are made based on projected demand and desired operational availability rates. The performance of the system is considered and determinations are made as to what stockage levels are required to support the desired level of operational availability.

The mind set must change to how might the performance of repair parts and secondary items be improved in order to increase or maintain the system's desired level of operational availability. Increasing the performance of each repair part within a system serves to extend the lifetime of that system, increase operational availability, reduce maintenance actions, and ultimately reduce operational and support costs. Thus, savings through Life Cycle Costing.

F. RECOMMENDATIONS FOR FURTHER STUDY

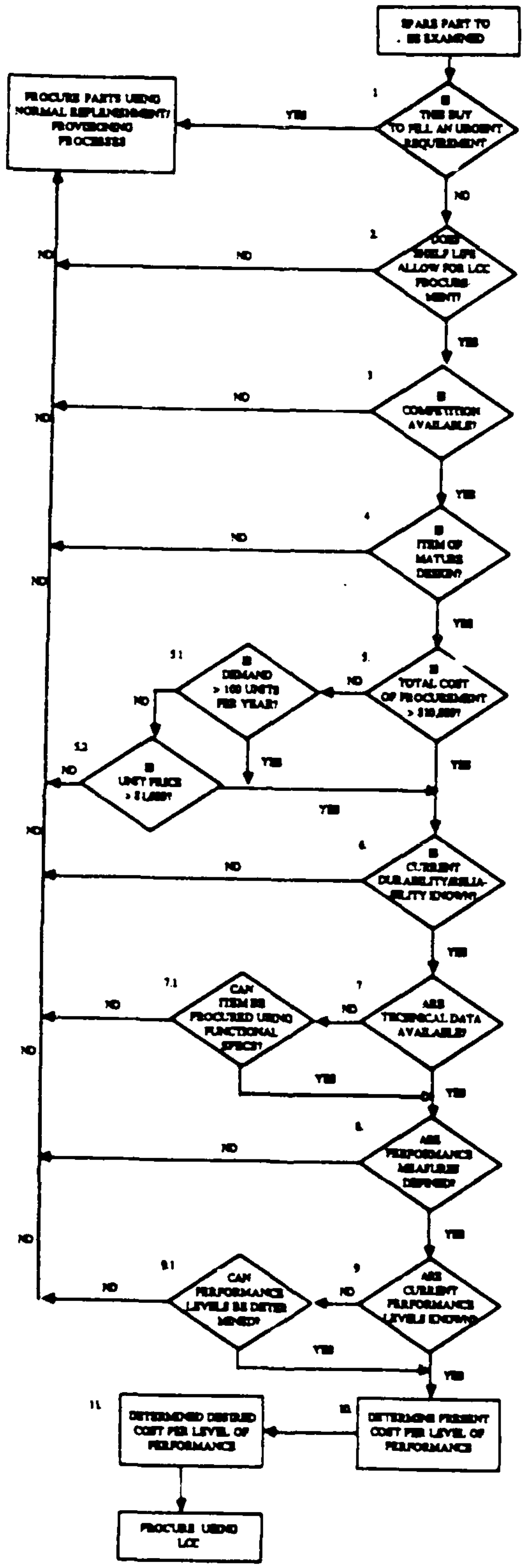
1. Conduct a study to determine the framework required to support Life Cycle Costing during the initial provisioning and replenishment of repair parts for the procurement of Army systems.

Initial provisioning and replenishment is currently based on demand and projected usage in order to support a desired operational availability. A study should be undertaken to identify the necessary modifications required, to the existing Commodity Command Standard System (CCSS), in order to collect and assess information for use in Life Cycle Cost decisions in repair parts procurement.

2. Perform a Cost-Benefit Analysis to determine the "usefulness" of the decision process.

A Cost-Benefit Analysis should be performed in order to determine if the benefits of Life Cycle Costing exceed the costs of administering the decision process. In addition, the analysis should assess the significance of each criterion and determine the utility of each step in the decision process. Perhaps all the criteria must not be met to benefit from Life Cycle Costing in repair part procurement.

APPENDIX A



The Graham Decision Model for Spare Parts

APPENDIX B

LIST OF COMMUNICATION AND ELECTRONIC REPAIR PARTS

NO.	NATIONAL STOCK NUMBER	PART NUMBER	NOMEN
1.	4030-00-133-6362	812	Hook, chain
2.	4030-00-202-3339	(81348) FFT276	Thimble, rope
3.	4030-00-243-4439	A186433	Clamp, wire
4.	4030-00-273-3071	AT2347	Terminal, wire
5.	4030-01-052-4507	(19564) 114425-1	Swaging Sl
6.	5340-00-057-6956	(96966) MS51929-2	Buckle
7.	5340-00-078-7029	(81349) MILC496	Clip
8.	5340-00-118-0018	(80063) SMB450477	Latch
9.	5340-00-185-2690	(80063) SMB896781	Mount
10.	5340-00-264-0822	(80063) SMC686879	Catch
11.	5815-00-356-3334	(80063) SCB69344	Forkclutch
12.	5815-00-392-7785	(80063) SMB1557187	Lever, manual
13.	5815-00-933-6738	(80063) SMB314921	Cable
14.	5815-01-083-0727	(80063) SMB314921	Bar, space
15.	5815-01-087-0893	(80063) SMD91564432	Keytop, Tele
16.	5855-00-137-6587	(80063) SMC657318	Plate, Back
17.	5855-00-237-4087	(49956) P536320	Ring, aligning
18.	5855-00-832-6518	(80063) SCC614588	Retainer
19.	5855-00-937-7707	(80063) SCC614663	Click, spring
20.	5855-01-069-4126	(22255) SMC772698	Cell, optical
21.	5905-00-104-8348	(81205) BACR14CJ332	Resistor
22.	5905-00-118-4559	(81535) A8344	Resistor
23.	5905-00-120-9154	(81535) A85451	Resistor
24.	5905-00-126-6696	(75042) GBT14750	Resistor
25.	5905-00-136-3891	(81349) MILR3900811	Resistor
26.	5935-00-080-1781	(83330) 271-102	Plug
27.	5935-00-125-2449	(81755) C6511-1	Polarizing
28.	5935-00-134-5646	(83330) 259-601	Adapter
29.	5935-00-283-3762	(70408) G21259-1	Connector
30.	5935-00-454-6979	(81349) MILC39024-12	Jack, tip
31.	5950-00-123-5778	(90073) 355-035	Coil, radio
32.	5950-00-420-1652	(02114) 25JT18A2053B	Shielding
33.	5950-00-612-4041	(72656) F1913-1-01	Bead
34.	5950-00-727-4668	(03765) CG2C03-92W	Transformer
35.	5950-00-731-6930	(03765) CG4C045	Transx, RF

No.	NATIONAL STOCK NUMBER	PART NUMBER	NOMEN
36.	5961-00-001-7340	(80063) SMA696869-7	Transistor
37.	5961-00-022-5670	(C7191) JAN2N3439A	Transistor
38.	5961-00-064-2379	(81349) SF1N649	Semiconductor
39.	5961-00-201-7132	(01295) A1111	Semiconductor
40.	5961-00-226-8579	(16758) B523365	Transistor
41.	5962-01-027-6863	(34309) AP106474-04	Microcircut
42.	5962-01-031-7030	(K0967) A030903	Microcircut
43.	5962-01-043-3940	(34335) AM74LS174J	Microcircut
44.	5962-01-050-0918	(34309) AP106474-138	Microcircut
45.	5962-01-057-7884	(24355) AD741LD	Microcircut
46.	6135-00-120-1019	(H1200) BA-031	Battery
47.	6135-00-485-7402	(80058) BA-1567/U	Battery
48	6135-00-801-3493	(80058) BA-1372/U	Battery
49.	6135-00-853-8670	(80204) C18-1-1965	Battery
50.	6135-00-930-0030	(H1200) BA-3030	Battery

Graham Decision Model Steps:

STEP ONE Is the buy to fill an urgent requirement?

STEP TWO Does the shelf life allow for Life Cycle Cost procurement?

STEP THREE Is competition available?

STEP FOUR Is item of mature design?

STEP FIVE Is total cost of procurement > $10,000?
- **STEP FIVE.ONE** Is demand > 100 units per year?
- **STEP FIVE.TWO** Is unit price > $1,000?

STEP SIX Is current durability/reliability known?

STEP SEVEN Are technical data available?
- **STEP SEVEN.ONE** Can item be procured using functional specs?

STEP EIGHT Are performance measures defined?

STEP NINE Are current performance levels known?
- **STEP NINE.ONE** Can performance levels be determined?

STEP TEN Determine present cost per level of performance?

STEP ELEVEN Determine desired cost per level of performance?

RESULTS: APPLICATION OF DECISION MODEL TO 50 REPAIR PARTS*

(* indicates repair part eliminated from decision process)

	ONE	TWO	THREE	FOUR	FIVE	FIVE.ONE	FIVE.TWO
1.	N/A	YES	YES	YES	NO	YES (878)	
2.	N/A	YES	YES	YES	NO	YES (700)	
3.	N/A	YES	YES	YES	NO	YES (2000)	
4.	N/A	YES	NO***				
5.	N/A	YES	YES	YES	NO	YES (1500)	
6.	N/A	YES	YES	YES	NO	YES (1541)	
7.	N/A	YES	YES	YES	NO	YES (1034)	
8.	N/A	YES	YES	YES	NO	YES (194)	
9.	N/A	YES	NO***				
10.	N/A	YES	YES	YES	NO	YES (1266)	
11.	N/A	YES	YES	YES	NO	NO (60)	NO (11.08)****
12.	N/A	YES	YES	YES	NO	NO (63)	NO (2.74)*****
13.	N/A	YES	YES	YES	NO	YES (2552)	
14.	N/A	YES	YES	YES	NO	NO (49)	NO (26.32)****
15.	N/A	YES	YES	YES	NO	NO (31)	NO (13.13)****
16.	N/A	YES	NO***				
17.	N/A	YES	NO***				
18.	N/A	YES	NO***				
19.	N/A	YES	YES	YES	NO	YES (845)	
20.	N/A	YES	YES	YES	YES		
21.	N/A	YES	YES	YES	NO	YES (1529)	
22.	N/A	YES	YES	YES	NO	YES (1613)	
23.	N/A	YES	YES	YES	NO	YES (1091)	
24.	N/A	YES	YES	YES	NO	YES (3845)	
25.	N/A	YES	YES	YES	NO	YES (5894)	
26.	N/A	YES	YES	YES	NO	YES (456)	
27.	N/A	YES	YES	YES	NO	YES (357)	
28.	N/A	YES	YES	YES	NO	YES (108)	
29.	N/A	YES	YES	YES	NO	YES (703)	
30.	N/A	YES	YES	YES	NO	YES (200)	
31.	N/A	YES	NO***				
32.	N/A	YES	YES	YES	NO	YES (124)	
33.	N/A	YES	YES	YES	NO	YES (200)	
34.	N/A	YES	YES	YES	NO	NO (54)	NO (4.13)*****
35.	N/A	YES	YES	YES	NO	NO (50)	NO (110.00)***
36.	N/A	YES	YES	YES	NO	YES (186)	
37.	N/A	YES	YES	YES	NO	NO (53)	NO (2.00)*****
38.	N/A	YES	YES	YES	NO	YES (310)	
39.	N/A	YES	YES	YES	NO	YES (396)	
40.	N/A	YES	YES	YES	NO	YES (336)	
41.	N/A	YES	YES	YES	NO	YES (133)	

	ONE	TWO	THREE	FOUR	FIVE	FIVE.ONE	FIVE.TWO
42.	N/A	YES	YES	YES	NO	YES (257)	
43.	N/A	YES	YES	YES	NO	YES (106)	
44.	N/A	YES	YES	YES	NO	NO (96)	NO (1.66)*****
45.	N/A	YES	YES	YES	NO	YES (402)	
46.	N/A	YES[2]	YES	YES	NO	NO (33)	NO (2.16)*****
47.	N/A	YES	YES	YES	NO	YES (370)	
48.	N/A	YES[2]	YES	YES	NO	YES (226)	
49.	N/A	YES[1]	YES	YES	NO	NO (44)	NO (.54)******
50.	N/A	YES[3]	YES	YES	NO	NO (21)	NO (9.95)*****

[1] Shelf life code 6 (Type II)--24 months.
[2] Shelf life code 7 (Type II)--36 months.
[3] Shelf life code 8 (Type II)--48 months.

RESULTS: APPLICATION OF DECISION MODEL TO 50 REPAIR PARTS

	SIX*	SEVEN	SEVEN.ONE	EIGHT	NINE	NINE.ONE	TEN/11
1.	NO	YES		NO********	********	********	********
2.	NO	YES		NO********	********	********	********
3.	NO	YES		NO********	********	********	********
4.	********	********	********	********	********	********	********
5.	NO	YES		NO********	********	********	********
6.	NO	YES		NO********	********	********	********
7.	NO	YES		NO********	********	********	********
8.	NO	YES		NO********	********	********	********
9.	********	********	********	********	********	********	********
10.	NO	YES		NO********	********	********	********
11.	********	********	********	********	********	********	********
12.	********	********	********	********	********	********	********
13.	NO	YES		NO********	********	********	********
14.	********	********	********	********	********	********	********
15.	********	********	********	********	********	********	********
16.	********	********	********	********	********	********	********
17.	********	********	********	********	********	********	********
18.	********	********	********	********	********	********	********
19.	NO	YES		NO********	********	********	********
20.	NO	YES		NO********	********	********	********
21.	NO	YES		NO********	********	********	********
22.	NO	YES		NO********	********	********	********
23.	NO	YES		NO********	********	********	********
24.	NO	YES		NO********	********	********	********
25.	NO	YES		NO********	********	********	********
26.	NO	YES		NO********	********	********	********
27.	NO	YES		NO********	********	********	********
28.	NO	YES		NO********	********	********	********
29.	NO	YES		NO********	********	********	********
30.	NO	YES		NO********	********	********	********
31.	********	********	********	********	********	********	********
32.	NO	YES		NO********	********	********	********
33.	NO	YES		NO********	********	********	********
34.	********	********	********	********	********	********	********
35.	********	********	********	********	********	********	********
36.	NO	YES		NO********	********	********	********
37.	********	********	********	********	********	********	********
38.	NO	YES		NO********	********	********	********
39.	NO	YES		NO********	********	********	********
40.	NO	YES		NO********	********	********	********
41.	NO	YES		NO********	********	********	********
42.	NO	YES		NO********	********	********	********

	SIX	SEVEN	SEVEN.ONE	EIGHT	NINE	NINE.ONE	TEN/11
43.	NO	YES		NO***********************************			
44.	**						
45.	NO	YES		NO***********************************			
46.	**						
47.	NO	YES		NO***********************************			
48.	NO	YES		NO***********************************			
49.	**						
50.	**						

* Durability/Reliability information could not be obtained for any repair part candidate. However the researcher proceeded with the application of the model.

STEPS ADDED BY AUTHOR FOR USE AT SACRAMENTO ARMY DEPOT

ARE ITEMS REPAIRABLE AT DEPOT LEVEL? All 50 communication and electronic repair parts were non-repairable.

IS ASCRIBED METHOD OF ACQUISITION LOCAL PROCUREMENT? All 50 communciation and electronic repair parts have recommended acquisition through the normal wholesale replenishment process.

APPENDIX C

Modified Graham Decision Model for Spare Parts for application at Sacramento Army Depot. (Modifications are identified in bold type. Sequencing of the other criteria are the same as originally developed, unless specifically identified as a change. However, criteria may be reflected as a different step in the process.)

STEP 1: **Is the Item Repairable at the Activity?**

STEP 2: **Ascribed Method of Acquisition Local Purchase?**

STEP 3: Is the Buy to Fill an Urgent Requirement?

STEP 4: Does Shelf Life Allow for LCC Procurement?

STEP 5: Is Competition Available?

STEP 6: Is Item of Mature Design?

STEP 7: Is Total Cost Greater than $10,000?

- STEP 7.1: Is Demand Greater than 300 per year?
- STEP 7.2: Is Unit Price Greater than $1,000?

STEP 8: **Are Technical Data Available?**

- **STEP 8.1:** **Can be Procured Using Functional Specifications?**

STEP 9: **Are Demonstrated Performance Levels Known?**

- **STEP 9.1:** **Can Performance Levels be Determined?**

STEP 10: Determine Cost per Level of Performance?

STEP 11: Determine Desired Cost per Level of Performance?

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